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June, 1977

FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH TO HUMAN RESOURCES ACCOUNTING

REPORT IV

AN EXAMINATION AND EVALUATION OF THE STATISTICAL MODEL

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This report uses predictive relationships between the Survey of Organizations and measures of organizational effectiveness established in earlier reports (Pecorella & Bowers, 1976a, 1976b, 1977) to develop the formal equations, including parameter values, to be used in the value attribution phase. Preliminary to this a series of issues arising from the theoretical and statistical bases of the current value approach are examined. These include: characteristics of variables to be included in the model, assumptions required

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for prediction of future performance, extension of the univariate methodology to the multivariate case, and the consequences of applying the methodology to this particular data file, for example, standardization of variables and elimination of outliers. A summary of previous and current analyses is also provided. A particular issue is how well the assumptions underlying the multivariate model are met in this particular data file. Analyses show there is no reason to believe the assumptions of multivariate linearity and normality are not met. Other analyses show that one cannot significantly reduce the number of predictor variables in the model. It is concluded that the presented model is appropriate, and the data set is ready to begin the value attribution steps.

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INTRODUCTION

Organizations have two systems of resources: the technical system which includes the physical plant, available knowledge and techniques, inventories, financial investments, etc., and the human system which includes not only the individuals who are part of the organization, but their skills, knowledge, established relationships and motivation to accomplish the organization's goals. Managers are becoming increasingly aware of the necessity to optimally utilize both resource systems. The variety of techniques, ranging from accounting to industrial engineering and systems analysis, that focus on fuller utilization of the organization's physical, technical and financial resources are well known. Information systems which provide knowledge necessary for fuller utilization of an organization's human or social system are in a relatively primitive state. The purpose of the present study is to explore and demonstrate a method for providing this type of information.

While Brogden and Taylor suggested as early as 1950 the development of indices measuring the value of an employee to an organization, it has not been until recently that much activity has taken place. Presently, there are three substantially different approaches to what has become known as human resources accounting.

(1) The "Incurred Cost" method--measuring the amounts already invested in the human organization (Brummet, Pyle, & Flamholtz, 1968; Pyle, 1970a, 1970b).

(2) The "Replacement Cost" method--estimating the cost of replacing the organization's human resources (Flamholtz, 1969).

(3) The "Present Value" method--estimating the future productive potential of today's human resources (Likert, 1967; Likert, Bowers, & Norman, 1969; Likert & Bowers, 1973).

The purpose of the present study is to demonstrate the appropriateness and the feasibility of the "Present Value" technique. Also called a <u>current value</u> approach, its purpose is to predict the future productive capacity of the organization based upon the current assessment of human resources. The study has two highly related, but sequential parts. The first phase examined the relationship between organizational effectiveness and measures of the human organization. This analysis included both simple and multiple correlations, and investigation of the time lag between the causal and intervening variables. These results are provided in the work of Pecorella and Bowers (1976a, 1976b, 1977). They were able to establish the existence of a significant relationship between the human variables as measured by the Survey of Organizations (SOO) and the two effectiveness measures, total variable expense (TVE) and absenteeism (ABS). This analysis was based on data from several different organizations with different technologies and included investigation of the relationships within these organizations as well as for the entire group. Additionally, the effectiveness measures were examined across time to see how the relationship to the human variables changed over time. The results show a strongly similar pattern of relationships within organizations and a definite time lag effect which produces the strongest relationships seven to ten months after the measurement of

the human variables. The next strongest relationship was found at the time surrounding the measurement of the human variables.

The second phase of the study involves the use of the observed relationships between the SOO and organizational effectiveness measures to demonstrate the current value methodology. [This approach is also termed Future Performance Trend Indicators (FPTI) since it involves the prediction of future organizational performance from current indicators of the state of the human organization.]

This report presents and examines in detail the technical and statistical implications of operationalizing a multivariate version of Future Performance Trend Indicators. First, some theoretical considerations of the current value model will be discussed. This will be followed by an extension of the univariate model to a multivariate situation. Next, the interplay between the current value methodology and the characteristics of the data file will be discussed. Finally, the mathematical model selected to estimate the FPTI will be presented. The assumptions underlying the model and how well they are met will be examined, as will the selection of an efficient set of predictors which are consistent across time. The next report will include the value attribution using the equations developed herein and a test, where sufficient data exists, of the assumptions that the predictor-criterion relationship estimated at one point in time is an adequate estimate of that same relationship at a subsequent point in time.

THE CURRENT VALUE METHOD

The conceptual and statistical bases of the current value methodology have been discussed elsewhere (Likert, 1973; Likert & Bowers, 1973; Bowers & Pecorella, 1975). However, it seems appropriate to review certain features implicit in this technique as applied herein to develop FPTI. Some theoretical and conceptual issues will be discussed followed by an extension of the univariate statistical procedures to the multivariate case.

Theoretical Issues

One of the distinguishing characteristics of FPTI is the prediction of future performance based on current knowledge. If this is to be done, several characteristics of the nature of the relationship between the predictor and criterion variables must be determined. This relationship is established by measuring the predictor variables at some point in time (T_0) and then measuring the criterion variables at one or more subsequent points in time (T_0+1, $T_0+2, \ldots T_0+k \ldots T_0+t$). The nature and extent of the relationship between the predictors at T_0 and the criterion at T_0+k, etc., are then established using an appropriate statistical methodology. A different equation for each value of k is assumed necessary. In order to make predictions the predictor variables are measured at some time subsequent to T_0, say T_0', and these values are then used to predict the state of the criterion variable at times $T_0'+k$. To do this it is assumed that the nature of the relationship between predictor and criterion is invariant from T_0+k to $T_0'+k$. In other words, we assume a constant relationship between the measurement of the human organization at some point in time and the measurement of organizational

effectiveness taken at a fixed subsequent time. As evidenced by the findings of Pecorella and Bowers (1977) in their analysis of time lag effects, it is important that the FPTI developed acknowledge the change in the predictive relationship from T_0+i to T_0+k. Thus we are not assuming a constant predictor-criterion relationship for the time periods between the collections of the predictive data.

The purpose of FPTI is to provide input about the human system to management information systems. With this in mind, it makes sense that only those costs which can be affected by the predictors would be included. Thus, variable, not fixed, costs (as in Total Variable Expense) must be used as criteria regardless of whether these costs are computed on a unit basis (Likert & Bowers, 1973) or in some other manner. Furthermore, it would seem useful to include as predictors only those variables which the organization can influence. While general economic conditions may affect turnover, any given organization has little influence on these conditions. Thus, one would not expect a change in organizational effectiveness to be effected through the impact of organizational practices on general economic conditions, and the subsequent effect on turnover since the initial impact on economic conditions is generally quite low. The conclusion is that predictors selected should be at least potentially subject to organizational influence and the criteria should be variable costs which can be impacted by changes in employee behavior.

An exception to these general guidelines for selection of predictors is suggested by the above example of the influence of external economic conditions on turnover. It may be desirable to include as predictors certain variables which, while not subject to organizational influence, modify the nature of the relationship between the criterion and those predictor variables subject to organizational influence. If these modifying variables are to be included, however, care must be taken when attributing value to changes in the state of the human organization to include changes in value attributable only to causal variables and not to the modifying variables which are only indicative of the changed relationship between the causal variables and the criterion.[1] An alternative to including these modifying variables in the equation would be to develop a set of equations for different combinations of values on these modifying variables. This is essentially the approach herein with regards to the modifying variable "time since administration of the SOO." Different equations are developed to describe the SOO-criterion relationship for different periods of time subsequent to the SOO administration.

There are two issues which are somewhat related to the one above: the level at which phenomena are measured and the theoretical model relating the measured dimensions of the human system to changes in organizational effectiveness. As stated by Pecorella and Bowers (1976) and by Mirvis and Lawler (1977), a causal model where links between the predictors and the criterion are known is desirable for accurate prediction. Mirvis/Lawler prefer a model which operates at the individual level. Attitude change is seen as leading to individual behavior change which leads to changes in organizational costs. What is omitted are the conditions subject to organizational control which lead to the attitude change. In the model used herein,

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[1]In the present study it was found that inclusion of certain structural variables, e.g., organizational size, permitted an increase in the ability to predict ABS. An investigation of two such variables is presented in Section 4, after the data set and the mathematical model have been discussed.

organizational conditions are viewed as leading to behavior change both directly and via attitude change. A related difference is that the present model is concerned with changes in the behavior of the group, not of the individual, even though the measures of group behavior may be computed by aggregating individual level measures. The necessity of aggregating individual measures to arrive at group or higher level measures does not invalidate the group concepts. The issue is not the arithmetic of score calculation but rather the researcher's theoretical perspective and its ability to explain what causes the observed phenomena. It seems unnecessary to point out that certain phenomena may be explained at the work group level while others are better explained at individual or organizational levels.

Multivariate Model

Likert (1973) presents the statistical methodology for relating a single measure of the human organization to a measure of organizational effectiveness. Briefly, this consists of (1) computing the Pearson product moment correlation between the measures, (2) converting both measures to standard scores ($Z_X = \frac{X-\bar{X}}{SD_X}$), (3) multiplying the standard score change in the predictor measure ($Z_X' - Z_X$) by the correlation coefficient to arrive at the predicted standard score change in the cost measure ($\Delta\hat{Z}_y$). This change is then converted to raw score form by multiplying it by the standard deviation of the Y scores. Mathematically:

X = human organization predictor score at time 1.

X' = human organization predictor score at time 2.

Y = actual criterion score at time 1+k

Y' = actual criterion score at time 2+k

$\hat{Y}$ = predicted Y score

Z_x = $\frac{X-\bar{X}}{SD_x}$ = standardized predictor score

Z_y = $\frac{Y-\bar{Y}}{SD_y}$ = standardized criterion score

ΔX = $X'-X$ $\qquad \Delta\hat{Y} = \hat{Y}'-\hat{Y}$

ΔZ_x = $Z_x'-Z_x$ $\qquad \Delta\hat{Z}_y = \hat{Z}_y'-\hat{Z}_y$

r_{xy} = Pearson product moment correlation between X and Y.

B_o = regression constant

B_1 = regression weight for X.

$$\hat{Y} = B_o+B_1X \qquad (1)$$

$$\hat{Z}_y = r_{xy} \cdot Z_x \qquad (2)$$

$$\Delta\hat{Z}_y = r_{xy} \cdot \Delta Z_x \qquad (3)$$

$$\Delta\hat{Y} = \Delta\hat{Z}_y \cdot SD_y \qquad (4)$$

Equation (1) is the univariate linear regression model in raw score form. Equation (2) is the same model in standard score form. Equation (3) is the calculation of change in the predicted standardized value of Y attributable to change in X. Equation (4) is conversion of the predicted standardized change in Y to raw score change. The conversion to standard scores makes B_o equal to 0 and B_1 equal to r_{xy} and thus makes the strength of the predictor-criterion relationship more evident. In a multivariate situation, however, the regression weight associated with each predictor will generally not be equal to either the zero order or partial correlation coefficients even if all variables are in standardized form. The regression weight will generally not give the amount of change in $\hat{Z}_y$ for a unit change in standard predictor scores

unless all predictors are orthogonal (Gordon, 1968; Linn, Werts & Tucker, 1971). Therefore, there is generally no advantage to standardizing any of the variables in a multivariate case. Because of the nature of the data peculiar to this study, however, it was necessary to standardize the scores. This is dealt with in the next section.

The multivariate methodology follows directly from the more simple univariate case. Remaining in a raw score format and using a _ to indicate a matrix of scores corresponding to the predictor variables, we have:

$$\underline{\hat{Y}} = \underline{B}_0 + \underline{BX} \qquad (5)$$

$$\Delta\underline{\hat{Y}} = \underline{B\Delta X} \qquad (6)$$

where $\underline{B}_0$ is a constant valued vector.

Equation (5) estimates the relationship between $\underline{Y}$ and $\underline{X}$. Equation (6) applies this relationship to an observed change in $\underline{X}$, $\Delta\underline{X}$, to arrive at a change in the predicted value of $\underline{Y}$. It should be noted that this procedure is algebraically equivalent to computing $\underline{\hat{Y}}'$ as the product of $\underline{B}$ and $\underline{X}'$ and then computing $\Delta\underline{\hat{Y}} = \underline{\hat{Y}}' - \underline{\hat{Y}}$. Mathematically:

$$\underline{\hat{Y}} = \underline{B}_0 + \underline{BX} \qquad (5)$$

$$\underline{\hat{Y}}' = \underline{B}_0' + \underline{B}'\underline{X}' \qquad (7)$$

$$\Delta\underline{X} = \underline{X}' - \underline{X} \qquad (8)$$

$$\Delta\underline{\hat{Y}} = \underline{\hat{Y}}' - \underline{\hat{Y}} = \underline{B}_0' + \underline{B}'\underline{X}' - (B_0 + \underline{BX})$$

Assuming $\underline{B}' = \underline{B}$ and $\underline{B}_0' = \underline{B}_0$ then:

$$\Delta\underline{\hat{Y}} = \underline{B}(\underline{X}' - X) = \underline{B\Delta X}. \qquad (9)$$

The assumptions $\underline{B}' = \underline{B}$ and $\underline{B}_0 = \underline{B}_0'$ are the same as the assumption discussed earlier, namely that the predictor to criterion relationship is the same at T_0+k as it is at $T_0'+k$. The appropriateness of a multiple linear regression model for the present data file will be discussed in Section 4.

Use of Change Scores

As indicated by previous conceptual discussions (Pecorella & Bowers, 1976a; Likert & Bowers, 1973) and the above statistical explication, the current value methodology rests on the observation of change in causal predictor variables which is then used to estimate a future change in some criterion of employee or work group behavior. Attention to issues in the measurement and analysis of change has increased with its popularity. A change score is defined as the difference between two measurements of the same attribute taken at different points in time. Thus, in the present study $\Delta \underline{X} = (\underline{X}' - \underline{X})$ is a change score.

Cronbach and Furby (1970) and Kessler (1977) both list four basic uses of change scores: (1) in the analysis of experimental data, (2) as criterion scores in correlational studies, (3) as indicators of theoretical constructs which cannot be measured directly and (4) to identify exceptional individuals (Cronbach & Furby, pg. 77). They do not, however, address themselves to the use of change scores as predictors of change in a criterion.

It is clear that the problems associated with the computation of change scores will exist regardless of their intended use. These problems center about two issues: (1) the reliability of change scores, and (2) the effects of "regression towards the mean."

As shown in equation (10), the reliability of a change score is a function of its component score (the scores on the attribute at T_0 and again at T_0') reliabilities (R_X & $R_{X'}$) and its component score intercorrelations ($r_{XX'}$).

$$R_{\Delta x} = \frac{VAR(X)R_X + VAR(X')R_{X'} - 2SD(X)SD(X')r_{XX'}}{VAR(X) + VAR(X') - 2SD(X)SD(X')r_{XX'}} \quad (10)$$

SD = standard deviation

VAR = variance

R = reliability

$r_{XX'}$ = Pearson product-moment correlation between X and X′

These effects may be more easily seen if we assume that VAR(X)=VAR(X′), and $R_X = R_{X'}$ (Kessler, 1977). Doing so, equation (10) becomes equation (11).

$$R_{\Delta x} = \frac{2VAR(X)(R_X) - 2VAR(X)r_{XX'}}{2VAR(X) - 2VAR(X)r_{XX'}} = \frac{R_X - r_{XX'}}{1 - r_{XX'}} \quad (11)$$

From equation (11) we see that the upper limit of the change score reliability is the reliability of its component scores (if $R_X \neq R_{X'}$ then the larger of the two is the limit of $R_{\Delta X}$). This is not a surprising result since we would hardly expect the difference between two component scores to be more reliable than the most reliable of the component scores. Equation (11) also demonstrates that as the correlation between X and X′ ($r_{XX'}$) increases, the reliability of their observed difference decreases. This may be seen intuitively if one considers that when $r_{XX'}$ is very high, we would say that X and X′ are almost identical to each other. Any observed difference between two nearly identical quantities will reflect little more than measurement error. Since the difference is our change score, it follows than when $r_{XX'}$ is high, the change score reliability, $R_{\Delta X}$ will be low.

It is interesting to note a potential fallacy here. Test-retest reliability, which is a measure of stability over time, is perhaps the most common conception of component score reliability. Any attempt to measure reliability in this manner while attempting to measure change results in conceptually (and often algebraically) equating R_x and $r_{xx'}$. This necessarily produces low change score reliabilities which can be attributed to low component score reliabilities (if $R_x=r_{xx'}$ is low) or to high component score intercorrelations (if $R_x=r_{xx'}$ is high). Thus, the reliability of the change scores will inevitably suffer if component score stability (the most common definition of reliability) and change are measured at the same time. The alternative, assuming a decision to use change scores, is to use a measure of reliability other than stability measured at the same time at which change is being measured. In the present study, R_x is measured by Cronbach's alpha, a measure of internal consistency. Thus, the potential fallacy described above is not of concern here. The change score reliabilities herein, reported in Table 1 along with component score reliabilities and intercorrelations, are necessarily a function of R_x, $R_{x'}$, and $r_{xx'}$. However, since the definition and computation of component score reliability (R_x,$R_{x'}$) is clearly distinct from that of component score stability over time ($r_{xx'}$), we are able to obtain generally high reliabilities for both the component and change scores. The figures reported in Table 1 were computed for the 797 work groups which have SOO measures available for T_0 and T_0'. These are the work groups for which change scores will be calculated and value attribution made.

The second problem associated with gain scores is a "regression toward the mean" effect which produces a negative correlation between $\Delta \underline{X}$ and $\underline{X}$. Kessler (1977) describes three mechanisms by which this effect occurs

Table 1

SOO CHANGE SCORE RELIABILITIES[1]

INDEX	^2R_X	$^2R_{X'}$	$^3r_{XX'}$	$^4R_{\Delta X}$
Supervisory Support	.91	.93	.43	.86
Supervisory Goal Emphasis	.83	.89	.49	.73
Supervisory Work Facilitation	.90	.92	.44	.84
Supervisory Team Building	.91	.93	.49	.84
Peer Support	.85	.88	.33	.80
Peer Goal Emphasis	.80	.82	.36	.69
Peer Work Facilitation	.89	.88	.32	.83
Peer Interaction Facilitation	.89	.90	.35	.84
Human Resources Primacy	.91	.91	.69	.71
Communication Flow	.81	.86	.54	.64
Motivational Conditions	.80	.86	.59	.59
Decision Making Practices	.65	.88	.62	.36
Satisfaction	.84	.89	.51	.73

[1]Figures shown are for all work groups with SOO scores at T_o and T_o' (N=797)

[2]R_X and $R_{X'}$ are the alpha coefficients for SOO indices measured at T_o and T_o' respectively.

[3]$r_{XX'}$ is the inter-wave correlation of T_o and T_o' SOO index scores.

[4]$R_{\Delta X}$ is the reliability of the change score $\Delta\underline{X}(=\underline{X}'-\underline{X})$ computed as shown on page 11.

and discusses the most popular correction for this the effect. Briefly, this correction involves the use of the residuals of the gain scores after they have been regressed on the T_0 component scores. Thus, the quantity $(\Delta X-\Delta\hat{X})$, where $\Delta\hat{X} = B_0+B X$, is used as a "residualized" gain score. Both Cronbach and Furby (1970), and Kessler (1977) argue that this correction is of limited or no use.

While the problems inherent in change score computation are fairly well known, their implications for the various uses of change scores are still being actively debated (Kessler, 1977). Furthermore, the debate centers on the four uses of change scores listed above and whether and how they should be corrected; to our knowledge the debate has not yet touched on change scores as used in the present study, i.e., as predictors in a regression equation developed from one wave of the component scores. Given this lack of guidance, our strategy has been to use the raw or uncorrected gain scores ($\Delta \underline{X}=\underline{X}'-\underline{X}$) as opposed to applying one of the various "correction formulae." Our rationale for this is two-fold: first, these correction formulae are shown to be of extremely limited use (Cronbach & Furby, 1970). Second, the current use of change scores does not fall into any of the previously examined purposes and there is no advantage in simply applying a correction formule without an explicit theoretical and/or statistical rationale.

DATA FILE CHARACTERISTICS

The conditions necessary for operationalization of the current value methodology have been enumerated by Likert and Bowers (1973). The extent to which these conditions can be met given the current state of knowledge is further described by Pecorella and Bowers (1976a). Pecorella and Bowers (1976a, 1976b, 1977) have also assessed the extent to which the data used in the present study meet these conditions and concluded this data file does meet the requirements for the development of future performance trend indicators using the current value approach to human resources accounting. Our purpose in this section is to describe the characteristics of the data in order to demonstrate the effect these characteristics have on the analyses and to provide a base from which the necessity and appropriateness of subsequent operations may be considered.

Previous Analyses

A brief review of previous analyses and a discussion of their implications for the development of FPTI is presented here. The analyses themselves and a more complete discussion are presented by Pecorella and Bowers (1976a, 1976b, 1977).

Data File Content

The data file contains two waves of scores from five organizations on 13 predictor variables from the Survey of Organizations (SOO) (Taylor & Bowers, 1972). These two waves of data were collected 11 to 24 months apart.

The file also includes scores on two criterion variables, Total Variable Expense (TVE), an ultimate criterion of organizational effectiveness and Absenteeism (ABS), a penultimate criterion of organizational effectiveness. Each criterion measure was collected from a different subset of four of the five organizations on a monthly basis, though not all months were collected for all organizations.

The 13 SOO indices were selected from 16 possible indices based on their internal consistency and the availability of complete data sets. ABS and TVE were selected from a set of five possible criteria as the ones for which sufficient data across time and across organizations was available. The existence of significant, directionally correct relationships was established by examination of the Pearson product moment correlations between each index and the criterion variables.

TVE measures are available for a total of 19 periods (A-S) covering 38 months and ABS measures are available for 10 periods (A-J) covering 28 months. This report will deal with periods A through I for TVE and A-J for ABS since these periods cover the duration of time (1 year) for which the FPTI's will be developed.

Performance Periods

It was desirable that the performance measure not reflect minor month to month fluctuation while still being capable of showing changes over time. Thus the decision was made to group consecutive months into periods in such a way as to maximize the consistency of the performance measure within each period. The monthly TVE and ABS data from each organization were subject

to a Smallest Space Analysis (Roskam & Lingoes, 1970). The results of the analysis were used to define multi-month performance periods where two criteria had to be met for a group of months to be assigned to a period: first, all months in a period had to be sequential; second, the values for the months had to be located empirically close together in N dimensional space (Pecorella & Bowers, 1976a). The period performance score (TVE & ABS) for each cost center was computed as the mean of that cost center's performance scores for the months included in that period. Thus, a total of 151 and 73 month by organization cells for TVE and ABS were reduced to 56 and 29 period by organization cells for TVE and ABS, respectively. Table 2 shows the resulting number of cases available from each organization for computation of the prediction equation for each TVE and ABS period.

We note that while the periods across organizations are similar the months contained in a period from each organization are not identical. Thus month T_0+3 (three months after the first wave of the SOO was administered) in one organization does not necessarily fall in the same period as does month T_0+3 for another organization. Also, since the size of periods varies from one to 11 months, it is possible, for example, to have an eight month period in one organization which corresponds to two four month periods in another organization.

One effect of defining performance periods in this manner was seen in the analyses examining the existence and generalizability of the multivariate relationships between 13 SOO indices and the criterion measures of ABS and TVE (Pecorella & Bowers, 1977). Given the hypothesis that this relationship changes as one gets further away in time from the collection of the SOO data, it was desirable to combine the periods from each organization which were similar, if not identical, in their distance from T_0 (first SOO administration) when computing the regression problems by period across organizations.

Table 2

NUMBER OF CASES BY PERIOD AND ORGANIZATION

TVE		A	B	C	D	E	F	G	H	I	
ORGANIZATION	II	61	--	61	61	61	--	--	--	--	
	III	--	--	254	254	254	--	--	--	248	
	IV	--	--	--	67	--	67	--	--	--	
	VI	127	127	127	127	127	131	51	51	161	
	Total	188	127	442	509	442	198	51	51	409	
ABS		A	B	C	D	E	F	G	H	I	J
ORGANIZATION	I	--	21	21	21	21	21	21	18	18	18
	II	--	--	46	107	46	76	61	24	--	--
	III	254	254	254	--	254	254	254	248	248	248
	VI	--	114	114	--	114	--	--	--	--	--
	Total	254	389	435	128	435	351	336	290	266	266

Therefore, the alphabetic labels assigned to each period were assigned so as to maximize the correspondence of the distances from T_0 of periods assigned the same labels. As a result, some periods are assigned two labels. Additionally, in any given organization two consecutive periods will always be labelled sequentially but not necessarily consecutively. This is demonstrated in Pecorella and Bowers (1977, pg. 22). The major implication of this feature is in the designation of which period regression equation will be used to predict performance for a given month. This will be discussed in the next report where changes in performance predicted by period will be converted to predictions by month.

Imputation

SOO data were collected by work group and criterion data were collected by cost center. Each cost center consists of one or more work groups. In order to relate the state of the organization as measured by the SOO to organizational effectiveness the cost center criterion scores were assigned to all work groups in the cost center. This imputation process provides a relatively large N (equal to the number of work groups) for analysis. However, it also reduces criterion variance by causing an artificially large number of tied scores. As a result, a conservative limit is placed on the size of the multiple correlation between the SOO indices and the criteria.

The alternative to imputation would have been to assign the average of the work group SOO scores to the cost center and perform the analyses at the cost center level. As indicated by the imputation rates (Pecorella & Bowers, 1977, pg.20), however, this would have drastically reduced the number of cases below the number necessary for this analysis. Therefore the imputation alternative was selected, despite the minimizing effect it has on the size of R.

Current Analyses

Standardization

As previously described, the data file contains predictor and criterion scores from five different organizations which for the purposes of this study are merged together to represent one hypothetical organization (Pecorella & Bowers, 1976a). In order to do this the relationships between predictors and criteria and the measures themselves must be in some sense comparable. This requirement will be discussed separately for criterion and predictor measures.

Criterion Standardization

The definitions of TVE and ABS have been listed previously for each organization (Pecorella & Bowers, 1977, p. 19). While not identical, each of these measures is similar to the same measure for the other organizations. However, the different bases from which these measures were computed and the different metrics used for each do indicate that these measures are not directly comparable. In order to merge these different score distributions into one data file, therefore, each organization's scores are standardized against its own distribution. This transforms each organization's scores to Z scores and allows comparison of the measures from the different organizations by giving them equal means ($\bar{Z}$=0) and standard deviations (SD=1) and eliminating their units of measurement. The necessity of performing this transformation raises the question of whether the transformation computed for each organization will be done within each performance period or across all performance periods.

Theoretically one would want to standardize within periods if each period's scores were sampled from different distributions and across periods if each period's scores were sampled from the same distribution. While it would be possible to test the null hypothesis (H_0) that the scores for each period are all drawn from the same distribution, the results would be of little practical use. Failure to reject the H_0 using a test of unknown power would say nothing about the probability of error in accepting the H_0. Rejection of the H_0 would not tell us which periods' scores were sampled from different distributions and which from the same distribution. Any _post hoc_ analysis would most likely indicate standardization across some periods and within others. When compounded by the merging of four organizations together, the resulting standardization scheme would be so intricate as to be unmanageable and senseless in practical terms.

Returning to the practical choice of standardizing either within or across periods (and not some combination thereof), it can be seen that standardizing within assumes a maximum number of different performance score distributions, i.e., each one different from all others. Where the performance scores of two or more periods are actually drawn from the same distribution, standardization within will provide results identical with standardization across those periods except for the effects of sampling error on the mean and standard deviation of the performance scores for the different periods. Thus standardization within was the method selected by Pecorella and Bowers (1977) to compute the regression of the performance measures on the SOO indices.

Computation of the current value of future performance will require that predicted changes in performance made in standard score form be converted to raw scores. This conversion will be accomplished using the same linear transformations that were used to standardize the performance data originally. If the scores are standardized within periods, a different transformation will be required for each period-organization cell and no transformation will be available to convert predicted standard scores to raw scores for those period-organization cells where the performance data is missing.

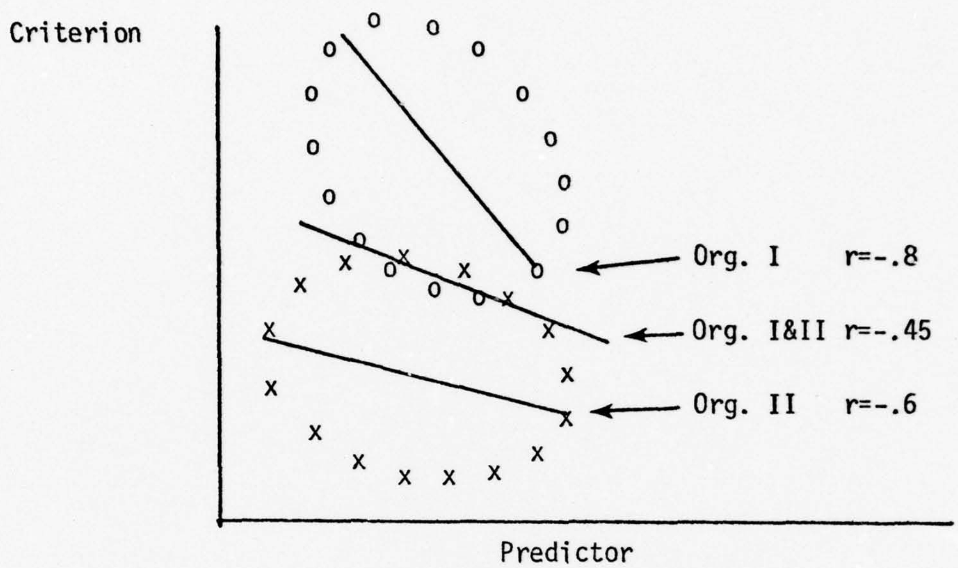
As shown in Table 2, there are a total of 30 period by organization cells where the predicted change in standard score could not be converted to a raw score for inclusion in the value attribution phase. Standardization across periods will result in a single transformation being used for each organization (on each performance measure). This transformation will thus be available to convert all predicted standard score changes to predicted raw score changes, regardless of whether criterion data was originally available for that particular period by organization cell. Thus the original requirement for standardization plus the problem of missing data indicates that standardization of criterion data across periods is preferable in this study.

The effect of the two different methods of standardization on the multiple R of the regression equations also requires exploration. Since standardization of the performance scores, whatever the method, is a linear transformation the particular method selected (within or across) will have no effect on the R for the prediction equation as long as only one organization's data is used in computing the equation. However, when two or more organizations

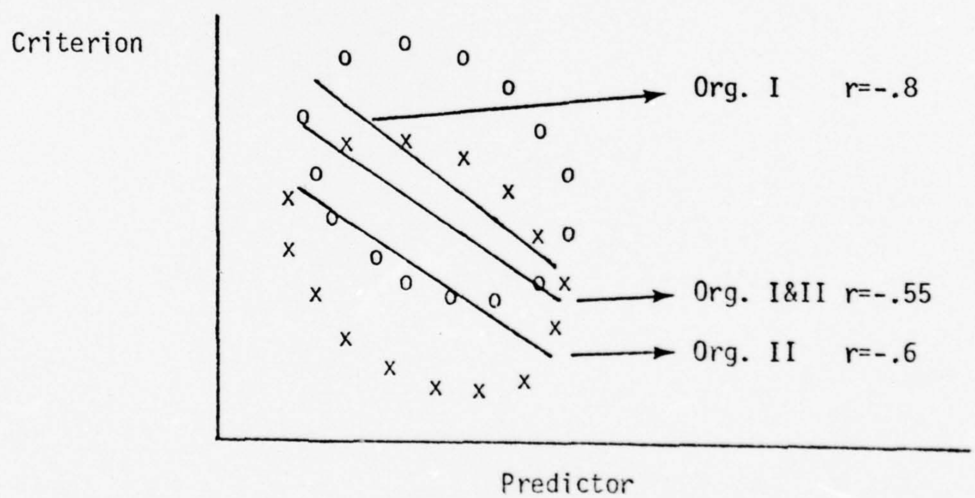
are merged to compute the prediction equation, standardization within each organization will result in a different linear transformation being applied to each organization's scores. In the multiple organization case the shift from one standardization scheme to the other does change the R's for the equations as shown in Table 3. This effect is best illustrated graphically. In figure 1 a simplified case with two organizations and only one predictor variable is depicted. In Figure 1A the predictor-criterion r's for organizations I and II are -.8 and -.6 respectively, and the r for the merged data is -.45. In Figure 1B a different linear transformation has been applied to each organization's criterion data as indicated by the change in the slopes of the individual regression lines. Since this does not effect the variation about each individual regression line, the r's for the individual organizations remain the same. However, when considered as one data set the variation about the regression line for the merged data has clearly changed. In this example variation about the regression line for the merged data in Figure 1B is reduced and the absolute value of r is increased from .45 to .55. Obviously, the net change will depend upon a number of factors including the N's for each organization and the specific transformations employed. The point is that there is a change. As can be seen by comparing R_w and R_a in Table 3, in the present study the changes in the positive direction are of greater magnitude and frequency than those in the negative direction.

Figure 1

Effect of Different Standardization Procedures



A. Standardization Within



B. Standardization

Table 3

EFFECT OF CRITERION STANDARDIZATION ON MULTIPLE R

TVE

	A	B	C	D	E	F	G	H	I
N	188	127	442	509	442	198	51	51	409
R_w	.46	.38	.34	.27	.27	.40	.57	.49	.26
P	.01	.16	.01	.01	.01	.01	.23	.58	.01
R_a	.51	.34	.39	.25	.27	.52	.57	.49	.28
P	.01	.35	.01	.01	.01	.01	.23	.58	.01

ABS

	A	B	C	D	E	F	G	H	I	J
N	254	389	435	128	435	351	336	290	266	266
R_w	.47	.30	.33	.34	.20	.32	.33	.43	.53	.43
P	.01	.01	.01	.33	.18	.01	.01	.01	.01	.01
R_a	.47	.48	.28	.39	.26	.33	.34	.35	.56	.45
P	.01	.01	.01	.10	.01	.01	.01	.01	.01	.01

R_w = Multiple R for equations with criterion standardized *within* periods.

R_a = Multiple R for equations with criterion standardized across periods.

Standardization of SOO Data

The original rationale for standardization of predictor scores (Likert & Bowers, 1973) and its inapplicability to the multivariate situation has been discussed in Section 2. An alternative reason for standardization would be that the SOO is in some sense a different measure when applied to different organizations. Although the manner in which the concepts the SOO measures are manifested may vary across organizations, the concepts themselves and the theory which ties them together are common to a large variety of organizations (Taylor & Bowers, 1972), including the organizations represented in the present study. Given this, differences in SOO scores across organizations are due to quantitative differences in the concept measured and not merely the metric employed; therefore, there is no real reason to standardize each organization's SOO scores against its own distribution to equate means at zero and standard deviations at one.

An alternative scheme would be to standardize the SOO across organizations. Since this would apply a single linear transformation to all organizations' SOO scores (for each of the 13 indices), this would have no effect on the SOO criteria correlations. Therefore, the SOO scores were left unstandardized in the present study.

In conclusion, it should be noted that the entire standardization issue is more an artifact of the combination of data from different organizations to illustrate the current value methodology than it is a feature of the method itself. The analogue of TVE for any single organization would likely be internally consistent, thus eliminating the need for standardizing. Should different measures be required, perhaps for different types of work, an empirical investigation of their inter-relationships would likely provide the best answer to combining the measures into a single data file. Should standardization be the method of choice, it would most likely be preferable

to standardize within different time periods, unless, as in the present study, situational constraints preclude this.

Work Group Level

Cost center scores on TVE and ABS reflect the contribution of all work groups in the cost center to its performance on these measures. Reporting the criterion in this manner has some specific advantages, particularly in regards to supervisory performance. Since TVE is measured at the cost center level, it includes both the direct effects of changes in supervisors' behavior at their work group level (other supervisors) and the indirect effects of their changed behavior at the subordinate work group level. The potential problem of distinguishing these direct and indirect changes and costing them separately is thus avoided as is the very real problem of identifying and costing a supervisory level analogue of TVE. There is a similar benefit with regards to ABS in that some of the effects of changes in supervisory absenteeism will appear at subordinate levels. Cost center reporting lumps these effects together with those that appear at the supervisors' level, again eliminating any need for measuring and costing supervisory and subordinate levels separately.

Despite the above advantages, this reporting procedure potentially introduces several sources of error into the value attribution for supervisory groups. First, it is unlikely that supervisor absenteeism has the same cost to the organization as does worker absenteeism. Second, the appropriateness of any given TVE-like measure for supervisors probably varies greatly across organizational levels. Third, supervisory leadership is a causal variable in the present theoretical model. The process of imputing cost center scores to all groups does not address the problem of attributing an appropriate portion of changed subordinate group value to changed supervisory behavior.

Thus it is likely that the error in the value attributed specifically to supervisory groups is increased, although this is not necessarily so for the attribution at the organizational level. Finally, while there are virtually no empirical studies bearing the relationship of organizational level to TVE or ABS type measures (Porter & Lawler, 1965; Berger & Cummings, in press), it can be plausibly hypothesized that organizational level does influence the nature of the relationship between the SOO predictors and performance. To the extent that this hypothesis is true, it suggests the use of different prediction equations at different organizational levels. However, it is impossible to implement this procedure unless the criteria are measured at the work group level.

Thus, while criterion measurement at the cost center level resolves several issues around measurement and costing of supervisory performance, it raises others. In the present study there was no option about how the criteria would be measured and, practically speaking, it is a moot point. However, in an actual implementation of a current value type of Human Resources Accounting, measurement of the criteria, especially at the supervisory level, is an issue that will require careful consideration from a variety of perspectives.

INVESTIGATION OF THE MODEL

The purpose of this section is to explore the application of our selected mathematical model to the data set at hand. Inherent in any model are assumptions about the way different characteristics or variables interrelate. The initial selection of the model is independent of the data in that it is derived primarily from a theoretical construct. Thus it naturally follows to examine the data set at hand for confirmation, or at least non-contradiction, of these assumed relationships.

The model selected to represent the relationship between SOO measures ($\underline{X}$, where $\underline{X}$ represents the matrix of indices with ith row ($X_{1i}, X_{2i},\ldots, X_{13i}$) and productivity measure (Y_i) is

(1) $\underline{Y} = \underline{B}_o + \underline{B}\ \underline{X} + \underline{\varepsilon}$

Actually, this is a model for 19 relationships in that we are investigating nine TVE and 10 ABS performance periods. However, from a theoretical standpoint, it follows that the type of model which is appropriate for one time period ought to be appropriate for all other periods. It is possible, though, that the relationship between absenteeism (ABS) and SOO may have a different form than that for total variable expense (TVE) and SOO. The analyses reported below each bear on a specific characteristic or assumption of the model. The areas investigated are: assumed linearity, distribution of the $\underline{\varepsilon}$ terms, variables to be included as predictors, modifier variables, and outlying data points.

Linearity

The model given by equation (1) includes the assumption of linearity both in the parameters B_i and in the variables X_i. (One may have linearity in the parameters, but not in the variables. For example, $Y = B_1X+B_2X^2$ is linear in the B's, but not in the X's. Some authors call this linear, second order. For the purposes of this study, we will use linearity to mean both linear in the parameters B_i and in the variables X_i.) In the univariate case, the assumption of linearity can easily be viewed by the examination of a scatter diagram. In the multivariate case, other techniques must be used.

An earlier report (Pecorella & Bowers, 1977) used the statistic $(eta)^2$ as a measure of linearity, and concluded that there was insufficient evidence to disprove linearity. Due to the theoretical and practical importance of this assumption, it is further examined here.

While with 13 predictor variables, linearity is in 14-dimensional space and impossible to explore directly using graphical procedures, it is possible to examine the residuals (the differences $Y_j-\hat{Y}_j$ where Y_j is an observed value and $\hat{Y}_j$ is the estimated value obtained by use of the fitted regression equation). The two classical techniques used here are to plot the residuals against the predicted or fitted values, $\hat{Y}_j$, and also against each of the independent variables. The plots against the independent variables focus on the linearity with respect to each of the SOO indices, while the plot against the predicted values will show any cumulative effects of non-linearity which are either not captured in a plot of $Y_j-\hat{Y}_j$ versus any single X_i or are due to a variable not included in the predictors, e.g., type of work.

The plots of the residuals with the predicted values will yield a horizontal band evenly distributed about the line $Y-\hat{Y} = 0$ if the model fits the data. For instance, if the relationship is not linear, but should have

either a cross-product term or quadratic term, the plot would have a parabolic shape (Draper & Smith, 1966). In Figure 2, several of the plots of the residuals against the predicted values are presented . (A complete compiliation is given in Appendix A.) At first glance, the appearance of the negatively sloped bands prominent. However, these bands are an artifact of imputing cost center values to each of the work groups of which it is comprised. This can be easily seen from the following graphs, using just one of the SOO indices. Assume there are three cost centers (A, B, & C) with four, five, and three work groups each. The overall relationship between SOO and either criterion (TVE or ABS) is negative, as indicated by the regression line. Each work group from a cost center will have a different SOO score but the same criterion score. This situation is shown in Figure 3.

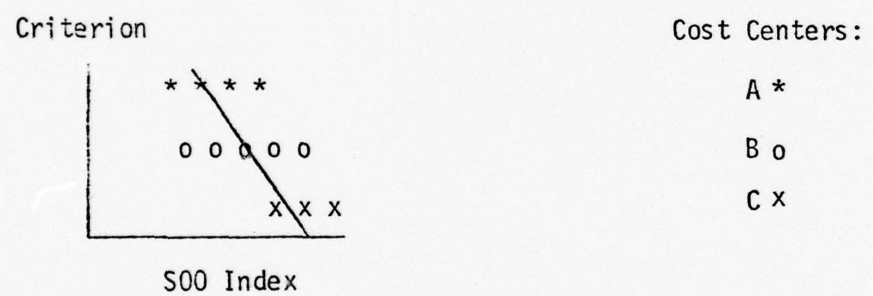
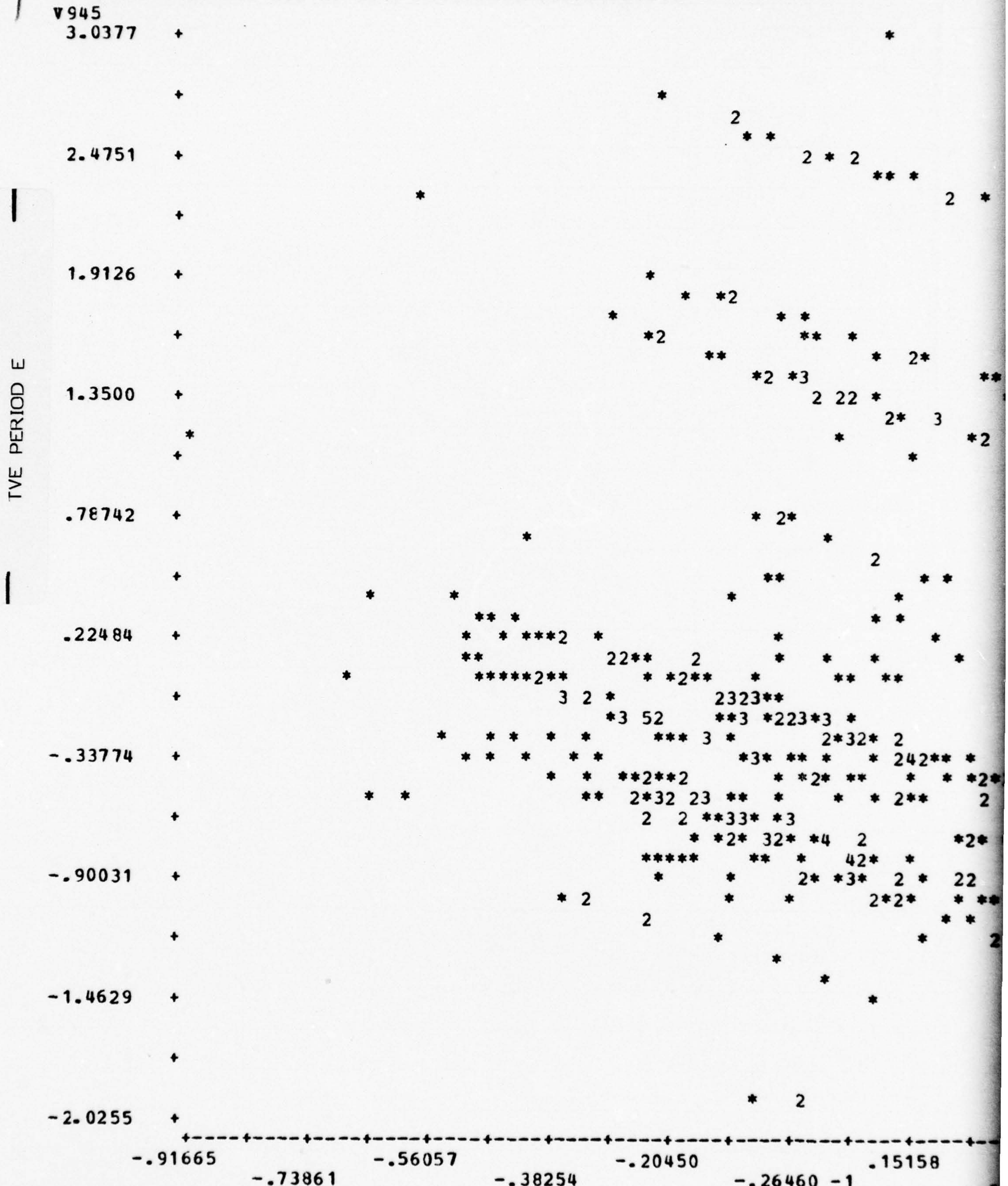


Figure 3

As can be seen in Figure 3, in any given cost center, the work group with the lowest SOO index score will have a relatively large negative residual, while the work group with the highest SOO score will have a relatively large positive residual. Because of the negative relationship between the two variables, the work groups with the lower SOO scores will have higher predicted criterion values than will the work groups with the higher SOO scores.

FIGURE 2

SCATTER PLOT



32

2

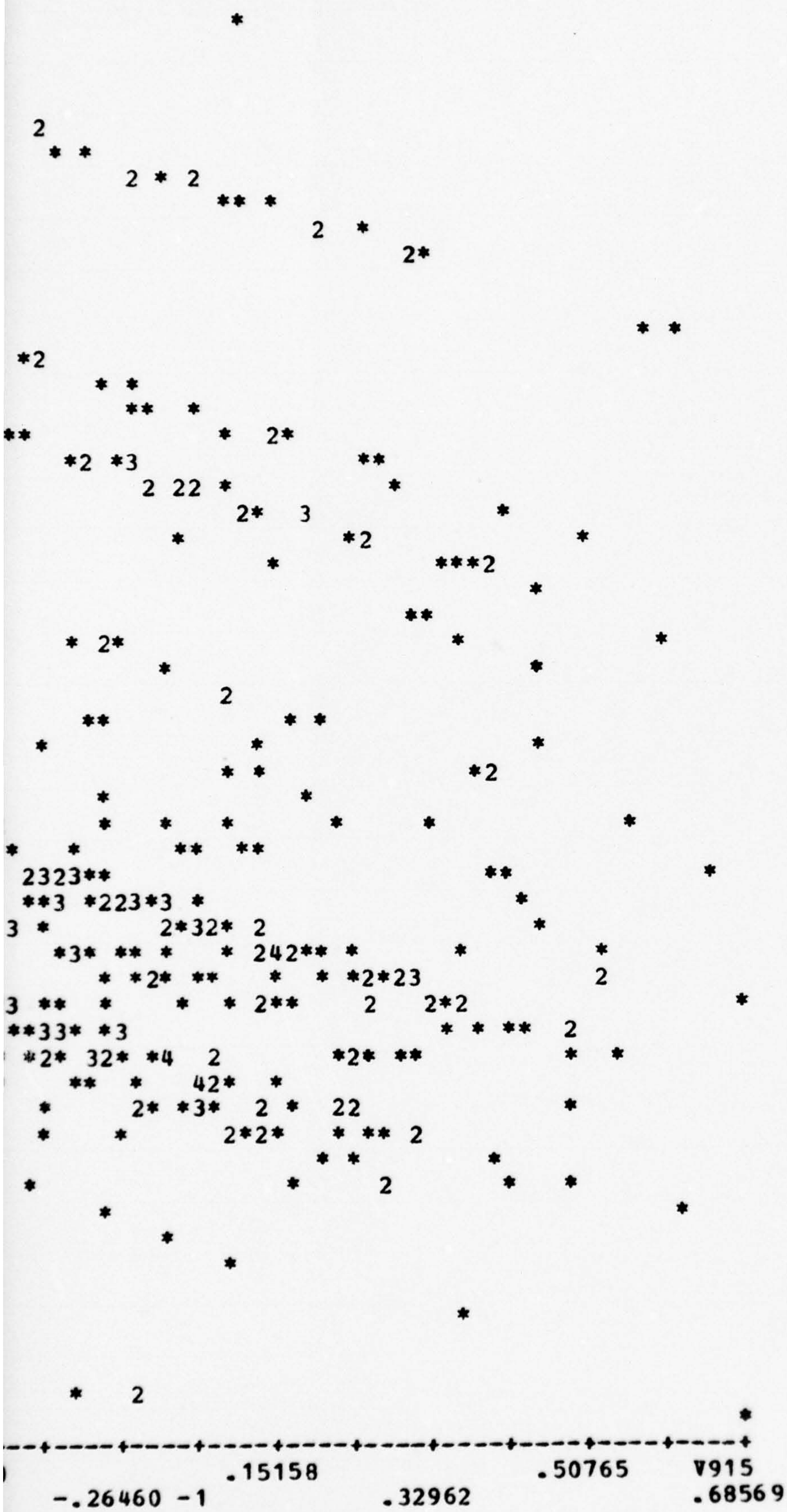
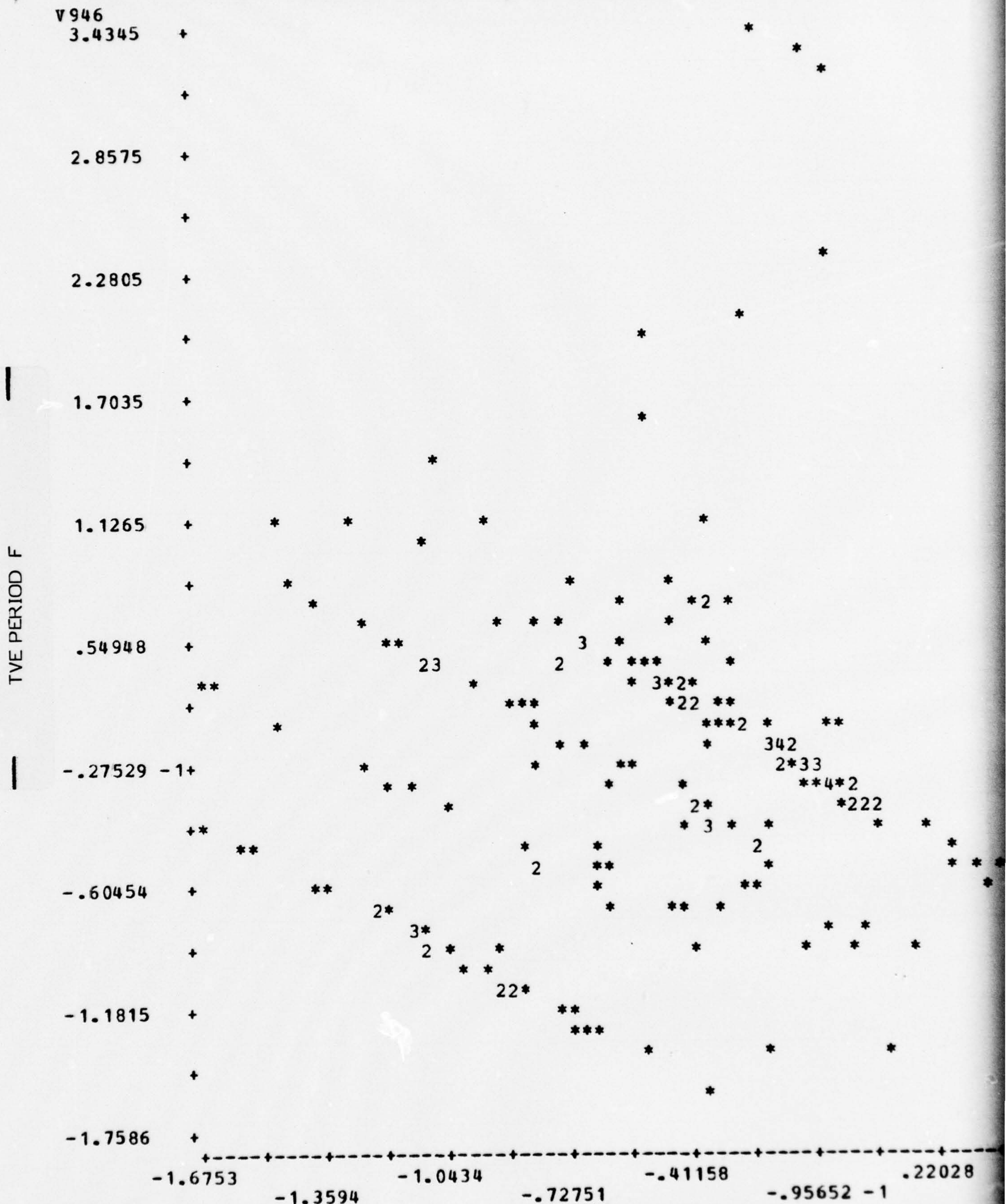


FIGURE 2

SCATTER PLOT



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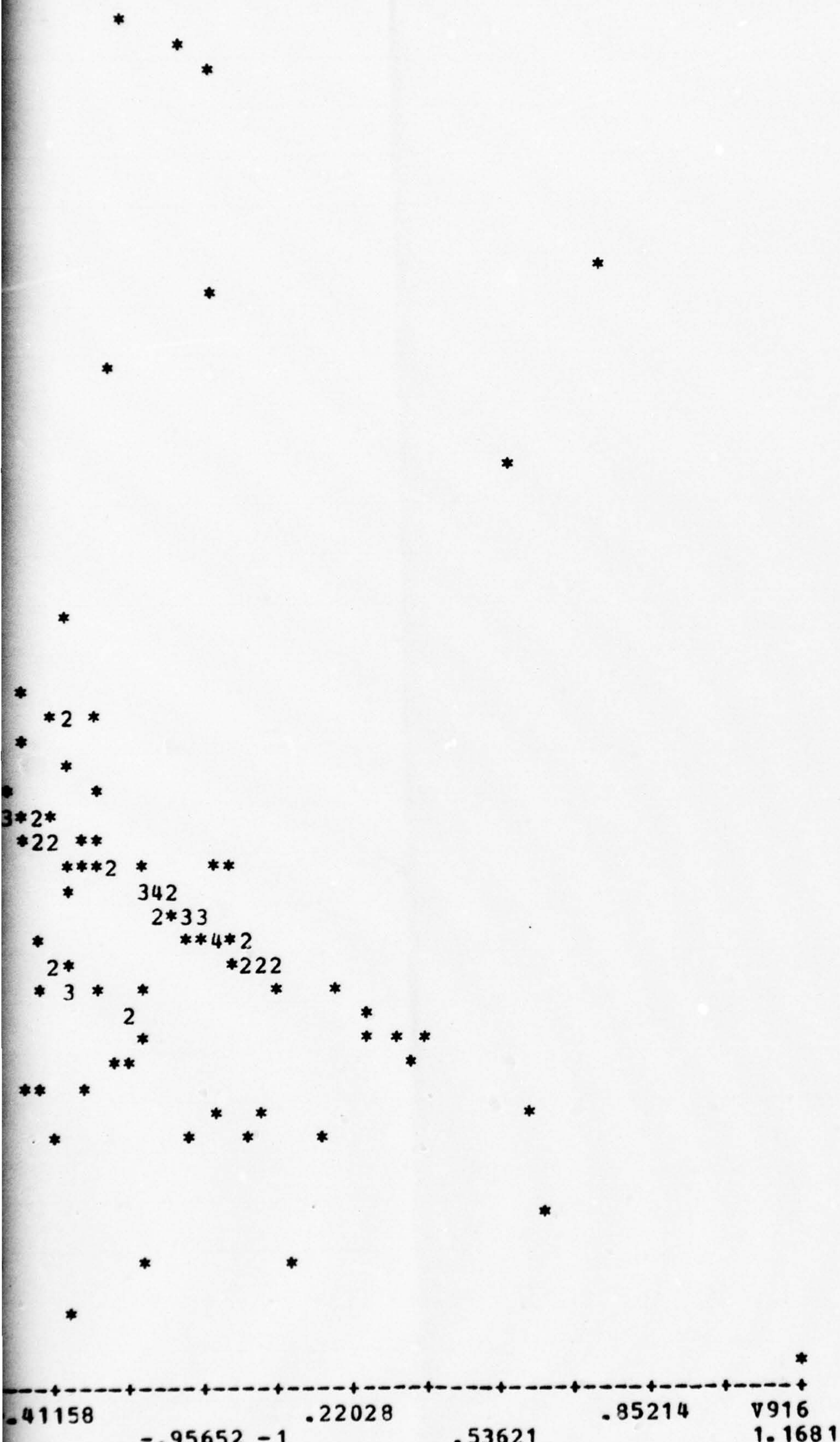
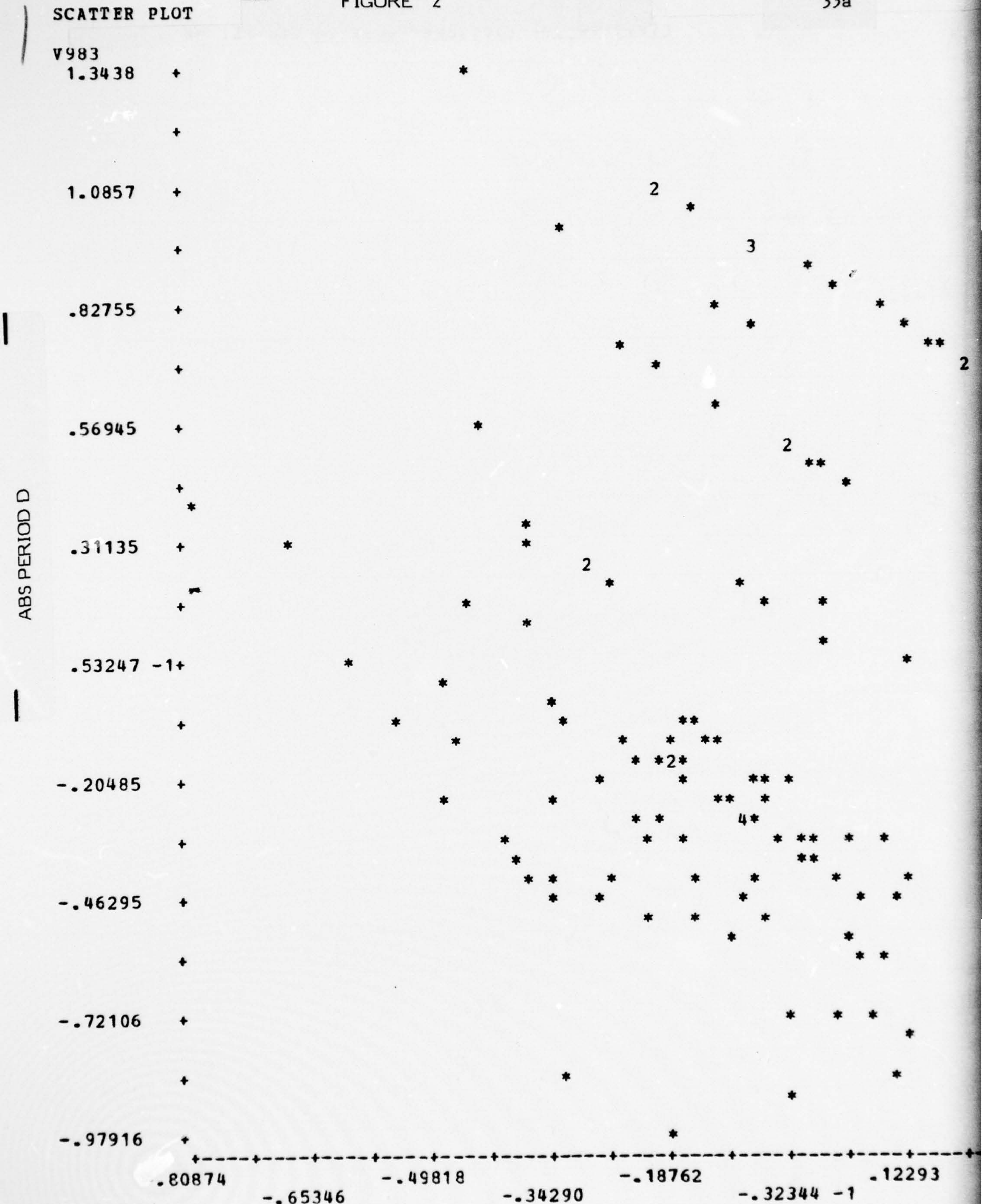


FIGURE 2


SCATTER PLOT
V983
1.3438
1.0857
.82755
.56945
.31135
.53247 -1
-.20485
-.46295
-.72106
-.97916
ABS PERIOD D
.80874
-.65346
-.49818
-.34290
-.18762
-.32344 -1
.12293

2

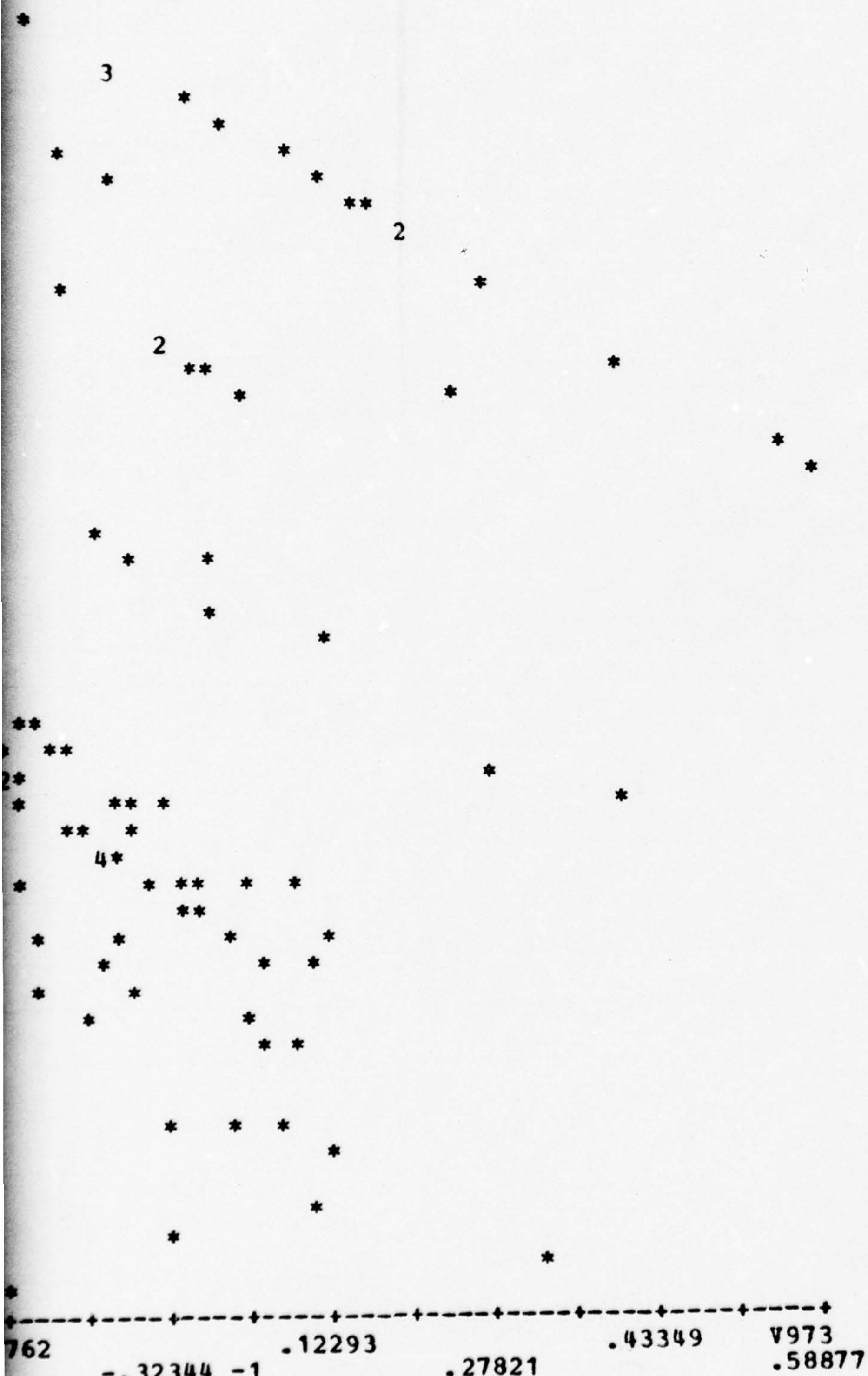
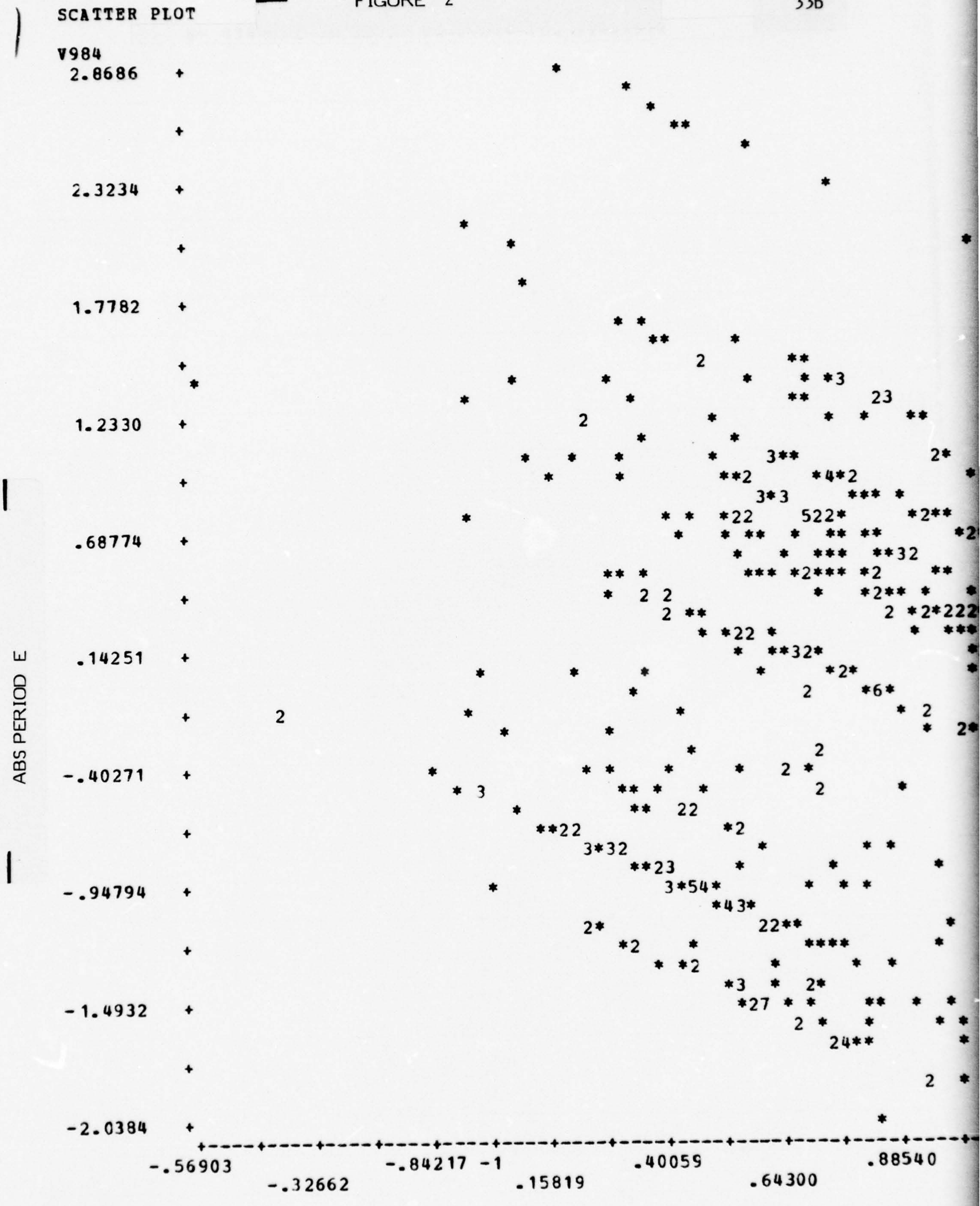


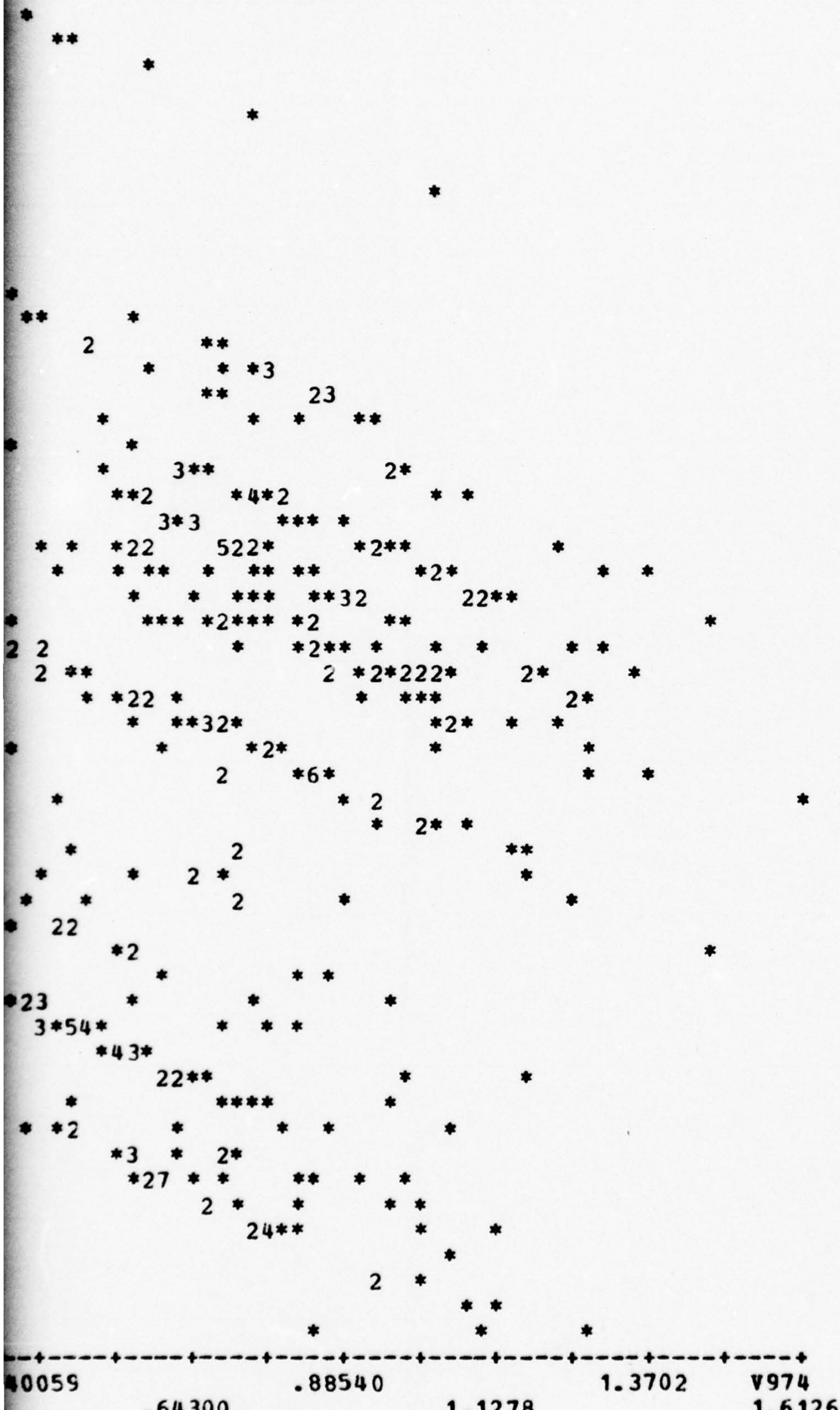
FIGURE 2


SCATTER PLOT
V984
2.8686
2.3234
1.7782
1.2330
.68774
.14251
-.40271
-.94794
-1.4932
-2.0384
ABS PERIOD E
-.56903
-.32662
-.84217 -1
.15819
.40059
.64300
.88540

33b

1

2



Thus, the work groups within a cost center with low SOO scores have high predicted criterion scores and relatively <u>negative</u> residuals while work groups from the same cost center with high SOO scores have low predicted criterion values and large <u>positive</u> residuals. When graphing the residuals versus the predicted values, this produces negatively sloped bands as demonstrated in Figure 4.

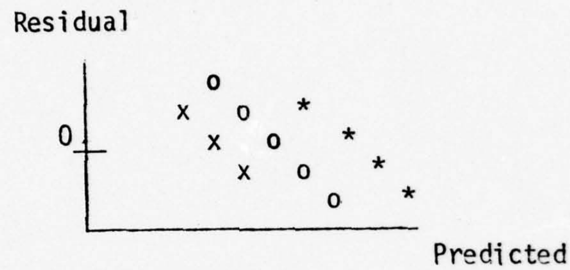


Figure 4

With this inherent pattern in mind, the interpretation of the plots in Figure 2 and Appendix A is that there is no evidence of non-linearity.

The second method of using the residuals to examine the linearity assumptions is to plot the residuals for both TVE and ABS against each of the 13 SOO indices individually. The 13 plots for each criterion-period are contained in Appendix B. An inspection of these 247 plots shows a basic pattern of a horizontal band of points which is considered supportive of model adequacy.

The examination of these plots and those of the residuals versus the predicted values, plus the previously reported analysis using eta^2, lends strong support to our assumption of multivariate linearity for the data set in hand.

Error Distribution

In investigating the normality of the error term ε in equation (1) the standard technique is to graph the frequency distribution of the residuals. Appendix C contains these histograms, a selected group of which are presented in Figure 5. The graphs can be seen to be basically symmetric and bell shaped, supporting the assumption of normality of the error terms. While the assumption of normality is not necessary for fitting the model, most, if not all, of the classical techniques for testing hypotheses related to the model are dependent on the accuracy of this assumption.

Predictor Variables

A third area of investigation is the number of predictors involved. In particular, it was of interest to explore the possibility of using only a significantly smaller subset of the 13 SOO predictor variables. The statistical methodology selected to analyze this issue was to apply a backward regression technique to a selected sample of performance periods for both criterion variables. The backward regression technique, in essence, begins with all 13 predictor variables in the model, and then begins to eliminate those which have little or no predictive value. This elimination process continues until only those variables with a predetermined level of statistically significant predictive ability remain. If a particular group of predictors were continually omitted from the model during this procedure, this would be considered evidence to support their omission from the final model.

```
HISTOGRAM      FIGURE 5

MIDPOINT    HIST%  COUNT FOR 943.V943  (EACH X= 1)

-1.7102        .2      1 +X
-1.4602      0.        0 +
-1.2102        .7      3 +XXX
-.96021       3.2     14 +XXXXXXXXXXXXXX
-.71021      13.1     58 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.46021      16.7     74 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.21021      18.1     80 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .39789 -1   13.3     59 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .28979      10.9     48 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .53979       9.3     41 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .78979       5.0     22 +XXXXXXXXXXXXXXXXXXXXXX
 1.0398       3.2     14 +XXXXXXXXXXXXXX
 1.2898       2.9     13 +XXXXXXXXXXXXX
 1.5398       2.5     11 +XXXXXXXXXXX
 1.7898        .7      3 +XXX
 2.0398        .2      1 +X

 MISSING            1877
 TOTAL              2319  (INTERVAL WIDTH= .25000)

                TVE PERIOD C
```

2

1)

```
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXX
```

0)

FIGURE 5

HISTOGRAM

MIDPOINT	HIST%	COUNT	FOR 947.V947 (EACH X= 1)
-.61570	2.0	1	+X
-.36570	13.7	7	+XXXXXXX
-.11570	41.2	21	+XXXXXXXXXXXXXXXXXXXXX
.13430	29.4	15	+XXXXXXXXXXXXXXX
.38430	7.8	4	+XXXX
.63430	3.9	2	+XX
.88430	2.0	1	+X

MISSING 2268
TOTAL 2319 (INTERVAL WIDTH= .25000)

TVE PERIOD G

HISTOGRAM FIGURE 5

MIDPOINT	HIST%	COUNT FOR 980.V980	(EACH X= 1)
-2.1432	1.2	3	+XXX
-1.8932	.8	2	+XX
-1.6432	4.3	11	+XXXXXXXXXXX
-1.3932	2.4	6	+XXXXXX
-1.1432	5.9	15	+XXXXXXXXXXXXXXX
-.89323	5.9	15	+XXXXXXXXXXXXXXX
-.64323	8.3	21	+XXXXXXXXXXXXXXXXXXXXX
-.39323	8.7	22	+XXXXXXXXXXXXXXXXXXXXXX
-.14323	13.0	33	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.10677	13.8	35	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.35677	9.1	23	+XXXXXXXXXXXXXXXXXXXXXXX
.60677	8.3	21	+XXXXXXXXXXXXXXXXXXXXX
.85677	5.9	15	+XXXXXXXXXXXXXXX
1.1068	.4	1	+X
1.3568	3.1	8	+XXXXXXXX
1.6068	3.1	8	+XXXXXXXX
1.8568	2.0	5	+XXXXX
2.1068	2.4	6	+XXXXXX
2.3568	.8	2	+XX
2.6068	.8	2	+XX
MISSING		2065	
TOTAL		2319	(INTERVAL WIDTH= .25000)

ABS PERIOD A

FIGURE 5

```
HISTOGRAM

MIDPOINT    HIST%  COUNT FOR 987.V987  (EACH X= 1)

-1.5548       1.4      4 +XXXX
-1.3048       2.1      6 +XXXXXX
-1.0548       3.5     10 +XXXXXXXXXX
-.80482       2.1      6 +XXXXXX
-.55482       7.6     22 +XXXXXXXXXXXXXXXXXXXXXX
-.30482      17.6     51 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.54823 -1   19.4     56 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .19518      18.0     52 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .44518      18.0     52 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .69518       6.9     20 +XXXXXXXXXXXXXXXXXXXX
 .94518       1.0      3 +XXX
 1.1952       1.7      5 +XXXXX
 1.4452        .3      1 +X
 1.6952       0.       0 +
 1.9452       0.       0 +
 2.1952       0.       0 +
 2.4452        .3      1 +X

 MISSING             2030
 TOTAL               2319   (INTERVAL WIDTH= .25000)
```

ABS PERIOD H

The backward regression technique was applied to four selected TVE and three selected ABS periods. The periods were selected so that they included different organizations, (in particular, one period with all organizations, one with a few, and one with only one organization) and covered the entire time span.

For this collection of seven analyses (of a possible 19), there were no subsets of even two or three variables which were omitted in all instances while all variables were omitted at least once. The significance level used for retaining a variable was liberal (.1). The conclusion is that there is insufficient evidence from the data at hand to consistently remove any set of three or more predictor variables (SOO) from this model.

Modifier Variables

As suggested in Chapter 2, it is possible that certain non-causal variables may act as modifiers of the relationship between the SOO indices and the criteria. It may be desirable to either compute separate FPTI equations for different values of the modifier(s), as was done for the performance periods, or to include these modifiers in the model itself. An example of a modifier that might be treated in the second manner is suggested by a previous analysis. Pecorella and Bowers (1977, pp. 27-31) found that the proportion of significant SOO index to criterion correlations decreased as capital intensity (CAPINTEN) increased. CAPINTEN is defined as the ratio of total dollar value of assets to total number of employees. In order to illustrate the inclusion of a modifier variable in the model, an analysis of CAPINTEN is presented here.

Before presenting the results of the analysis, some characteristics of CAPINTEN should be noted. The values on this variable were computed from Fortune 500 figures for 1971, the end of the period of SOO and performance data collection. As such, CAPINTEN is computed for the entire corporations to which the particular organizations in this study belonged. Thus, while CAPINTEN undoubtedly has a strong relationship to the capital intensity of the organizations in this study, it is actually a feature of the corporation as a whole. Another feature of the CAPINTEN variable is its limited variance. The four sites from Organization II all receive the same corporate score on CAPINTEN as do the three sites from Organization VI. Thus, for each criterion there is a maximum of four levels of CAPINTEN, and often fewer, that enter into the analysis. In fact, in TVE periods B, G, and H, and ABS period A there is only one level of the CAPINTEN variable present and therefore it cannot be included in equations for these periods.

Since it is our purpose to examine the predictive ability of a model including CAPINTEN and 13,500 indices against a model containing only the 13 SOO indices, the terminology of Bottenberg and Ward (1963) and Draper and Smith (1966) will be used herein. Briefly, these authors define a restricted model as the model with the variables which have already been included in the prediction equation. The full model consists of the restricted model plus a set of one or more variables to be tested for inclusion in the equation. This test uses the sum of squared deviations from the mean (SS) associated with each model in a "partial" or "sequential" F-test (Draper & Smith, 1966, p. 71) to determine the significance of the increased prediction provided by the variables in the full model but not in the restricted model. The models will be referred to here by a subscripted R:

R_{13} means the model with 13 SOO indices (restricted model) or the multiple R for that model, depending on the context; R_c means the model with CAPINTEN plus the 13 SOO indices (full model) or its multiple R, again depending on the context. Finally $R_c - R_{13}$ means comparisons of the full model with the restricted model or the change in the value of R from one model to the other. The value of p reported for $R_c - R_{13}$ is determined by the sequential F-test described above.

Table 4 shows the effect of including CAPINTEN in the model for TVE. There are seven periods where its effect could be examined. $R_c - R_{13}$ was significant ($p<.05$) in only two of the seven periods (E & F). Examinations of the organizations represented in each period (Table 2) shows that periods E and F had three and two levels of CAPINTEN, respectively, while periods A, C, D, and I had two, three, four, and two levels, respectively. Therefore, it does not appear that the failure of CAPINTEN in periods A, C, D, and I is due to limited variance. Rather, in general, it seems that CAPINTEN does not aid in predicting TVE, although close examination of periods E and F might reveal particular circumstances where we could expect CAPINTEN to have some predictive value.

Table 5 shows the results of the analysis for absenteeism (ABS) plus some other results discussed below. Of the nine periods where R_c could be compared to R_{13}, seven show a significant ($p<.01$) value for $R_c - R_{13}$. Furthermore, where $R_c - R_{13}$ is significant, its size is moderate to large ($.07 \leq R_c - R_{13} \leq .26$; mean $[R_c - R_{13}] = .16$). Thus, the addition of the modifier CAPINTEN to the model significantly improves our ability to predict ABS. This is despite the fact the CAPINTEN is measured at the corporate level and has limited variance.

Table 4

EFFECT OF CAPINTEN ON PREDICTION OF TVE

	A	B	C	D	E	F	G	H	I
N	188	127	442	509	442	198	51	51	409
R_{13}	.51	.34	.39	.25	.27	.52	.57	.49	.28
P	.01	.35	.01	.01	.01	.01	.23	.58	.01
R_C	.51	NOTE[2]	.40	.26	.34	.67	NOTE[2]	NOTE[2]	.28
P	.01	--	.01	.01	.01	.01	--	--	.01
R_C-R_{13}	0	--	.01	.01	.07	.15	--	--	0
P	NS[1]	--	NS	NS	.01	.01	--	--	NS

NOTE[1] NS = not significant at the .05 level.

NOTE[2] CAPINTEN has only one level for the cases in this period, therefore, it does not enter into the equation.

Table 5

EFFECT OF CAPINTEN AND SIZE ON PREDICTION OF ABS

	A	B	C	D	E	F	G	H	I	J
N	254	389	435	128	435	351	336	290	266	266
R_{13}	.47[1]	.48	.28	.39	.26	.33	.34	.35	.56	.45
R_C	NOTE[3]	.64	.50	.41	.49	.46	.60	.42	.56	.51
$R_C - R_{13}$	--	+.16	.22	.02	.23	.13	.26	.07	0.0	.06
P	--	.01	.01	NS[2]	.01	.01	.01	.01	NS	.01
r_{CS}	--	.87	.91	-.42	.91	.97	.97	.97	1.00	1.00
R_S	NOTE[3]	.56	.47	.62	.45	.44	.60	.43	.56	.51
$R_S - R_{13}$	--	.09	.19	.21	.19	.11	.26	.08	0.0	.06
P	--	.01	.01	.01	.01	.01	.01	.01	NS	.01
R_{CS}	NOTE[3]	.65	.50	.62	.49	.52	.60	.53	NOTE[4]	NOTE[4]
$R_{CS} - R_C$	--	.01	0.0	.21	0.0	.06	0.0	.11	--	--
P	--	.01	NS	.01	NS	.01	NS	.01	--	--
$R_{CS} - R_S$	--	.09	.03	0.0	.04	.12	0.0	.10	--	--
P	--	.01	.01	NS	.01	.01	NS	.01	--	--

NOTE[1] $p<.01$ for all values of R and r shown in this table.

NOTE[2] NS = not significant at the .05 level.

NOTE[3] CAPINTEN has only one level for all cases in this period, therefore, it does not enter into the equation.

NOTE[4] $r_{cs}=1.00$ for this period. Therefore, SIZE and CAPINTEN cannot both be in the model.

The definition of CAPINTEN as a ratio with total number of people in the corporations as the denominator suggests that it may not be CAPINTEN but rather corporate or organizational size or total assets that is increasing our ability to predict absenteeism. A positive relationship between organization size and absenteeism has been reported consistently in the literature (Porter & Lawler, 1965; Berger & Cummings, in press). Therefore an analysis examining the ability of a model including a SIZE variable to predict ABS was conducted. An estimate of the size of each organization and each site within each organization was available from the number of individuals responding to the SOO at each site. Therefore, another variable, SIZE, was so defined and entered into a model with the 13 SOO indices to predict ABS. This variable has more levels (10) than CAPINTEN and reflects a structural feature of the specific organizations and sites rather than of the entire corporations.

The investigation of models for ABS including SIZE is two-fold. First, R_S is compared to R_{13} to determine if SIZE does increase our ability to predict ABS. Second, a model including SIZE and CAPINTEN (R_{CS}) is compared to the models including either SIZE or CAPINTEN. This allows us to investigate the increase in predictions of a model containing both variables over a model containing either one of the variables but not the other.

The Pearson product moment correlation between SIZE and CAPINTEN over all sites is .85 ($p<.01$). This correlation (r_{CS}) will not be constant over periods since different organizations and sites within organizations enter the analysis in different periods. Therefore, the values of r_{CS} for each ABS period are listed in Table 5.

The comparison of R_s to R_{13} shows that in eight of the nine periods where the analysis is possible, R_s-R_{13} is significant. As with R_c-R_{13}, the significant values are generally moderate to large (.06 $\leq R_s-R_{13} \leq$ .26; mean [R_s-R_{13}] = .15). The values of R_s-R_{13} and R_c-R_{13} are generally similar. This overall pattern of similar magnitudes for R_c-R_{13} and R_s-R_{13} and the high values of r_{cs} indicate that SIZE and CAPINTEN are accounting for approximately the same additional variance in ABS over and above the variance accounted for by the SOO for which variables. The notable exception to this pattern is period D where r_{cs} is of moderate size (-.42) and R_c is not larger than R_{13} but R_s is considerably larger than R_{13}. This is probably an artifact of the manner in which SIZE and CAPINTEN were defined. Examination of ABS period D in Table 2 shows that CAPINTEN will have only two levels while SIZE will have five levels (one for Organization I and four for Organization II). Thus, CAPINTEN does not add to the model's ability to predict but SIZE does. Because of this unique situation, period D will not be considered in the following discussion.

Additionally periods I and J are not included in the comparison of R_{cs} to R_c and R_s because r_{cs} for these periods equal 1.00. Thus, entry of SIZE into the model for periods I and J is completely redundant with entry of CAPINTEN and vice-versa. This leaves us with periods B, C, E, F, G, and H in which to compare R_{cs} to R_c and R_s.

Comparison of R_{cs} to the larger of the two values of R_c and R_s (thus looking at the smaller of the two values of R_{cs}-R_c and R_{cs}-R_s) shows that inclusion of both predictors generally adds little to the prediction of ABS over the inclusion of whichever predictor (SIZE or CAPINTEN) is most effective alone. The statistical significance of these values (R_{cs}-R_s & R_{cs}-R_c) is

high ($p<.01$) despite the small magnitude of R_{cs}-R_s and R_{cs}-R_c because of the large N involved. Periods F and H do show a moderate increase in R_{cs} over R_s and R_c. This is unexpected since r_{cs} is extremely high (.97) in both these periods. Apparently the variances that are unique to SIZE and CAPINTEN are both common to ABS in these periods. However, there is no increase in R_{cs} over R_c or R_s for period G, which includes the same organizations as periods F and H.

In summary, the three models, R_{cs}, R_s, and R_c are strikingly similar in their ability to predict ABS. However, whether CAPINTEN or SIZE adds more to the SOO model is a function of the particular period and the organizations in the period. Exceptions to this include period D which has a unique combination of CAPINTEN and SIZE values, and periods F and H where R_{cs} does offer some moderate improvement over both R_c and R_s.

The above analyses demonstrate two variables, closely related, which improve the ability of a model containing the 13 SOO indices to predict ABS. A variety of hypotheses as to how this improvement occurs could be generated but any causal link between either CAPINTEN or SIZE and ABS would be mere conjecture at this point. Therefore, even if e.g., SIZE, were included in the model, change in value of the organization's human resources would not be attributed to a change in SIZE. Rather, the effects of change in SIZE would have to be partialled out so that value would be attributed only to changes in the SOO indices (or other causal variables). This is a rather complex procedure and would go considerably beyond the already intricate analyses that have been conducted and well beyond the intended scope of this study.

The analysis presented here is offered only as an example of some possible modifying variables. In an actual application the modifier(s) considered and selected would be a function of both empirical and theoretical considerations.

Outliers

When one encounters a few data points which are deviant from the bulk of the sample or from expectations one is always faced with the decision of whether or not to retain the data or eliminate it. A variety of strategies for making this decision are available. The one selected depends on the source of the data, the purposes for which it will be used and the bent of the researchers.

Given that one is willing to consider eliminating deviant data, perhaps the most common approach is to identify questionable data and determine if an explanation can be found for its deviance. This approach has already been used in the present study in the examination of the SOO data and the various criterion measures from different organizations to determine if the data set was suitable for the application of the current value methodology. A prime example of this is the elimination of the TVE measures from Plant 2 in Organization VI for periods A through E due to organizational practices which resulted in increases in TVE for high producing cost centers and decreases in TVE for low producing cost centers. [This issue of organizational practices which reverse the expected relationship of SOO to organizational functioning is covered more thoroughly in Taylor & Bowers, (1972)]. Thus, the source of the data and the effects of "intrusive factors" have already been considered in establishing the data file.

In examining the plots of the residuals, the existence of extreme values or outliers became apparent. When investigating the nature of outliers (defined as values in excess of 3.5), no systemic reasons could be found. (An example of systemic reasons would be the same cost center over time.) Thus, these deviant values are presumably a result of misreporting, transcription error, or statistical quirk. However, upon examination of the actual criterion standard scores, it was found that they ranged from 4.8 to 10 (in absolute value), implying inaccuracy rather than probabilistic deviance. Table 6 presents the information concerning these outliers as well as the Multiple R values when including and excluding these cases. Results reported in Tables 2 through 5 are for analyses conducted prior to elimination of the data shown in Table 6. The plots shown in Figure 2 and Appendices A through C are the results of analyses conducted after the elimination of these data. As statistical theory predicts, these outliers have unusual leverage in fitting the regression model to the data, and therefore, distort the results. It is for this reason that these cases were removed from the analysis.

Deletion of some cases from each organization's file will alter the mean and standard deviation of the performance score distribution for that organization. The particular transformation used and therefore the standard scores arrived at are a function of these statistics. Since different transformations are used for and different data is deleted from each organization, the effect of deleting data on the standard scores will vary across organizations. Obviously, when standard scores from one organization shift in one manner and those from another organization shift differently, the relationship between these scores and the SOO scores will change. Necessarily, this will only happen if the performance score distributions are restandardized after the data are deleted. To avoid this unpredictable change in

the predictor-criterion relationship, performance score distributions have not been restandardized after deletion of the data. Because of this, the actual mean and standard deviations of the performance score distributions with the data deleted are not exactly zero and one respectively for some organizations and some periods. Since so few cases were deleted, however, the parameters will be quite close to these values. The changes in R shown in Table 6 are thus solely the result of the deletion of outliers and not the result of deletion plus restandardization.

Table 6

CHARACTERISTICS OF DELETED DATA

Criterion	Period	Criterion Standardized Score of Deleted Cost Centers[1]	Before Deletion		After Deletion	
			N	R	N	R
TVE	D	9.15	509	.25	505	.28
	H	7.79	51	.49	45	.57
ABS	C	7.13	435	.28	434	.31
	D	4.84 6.26	128	.39	121	.40
	E	-10.15	435	.26	434	.30
	H	6.9	290	.35	289	.42

[1]In all periods except ABS-D, only one cost center was eliminated. In ABS-D, two cost centers were eliminated.

CONCLUSIONS

The analyses and discussions presented thus far can be divided into two somewhat overlapping categories. First, a variety of statistical considerations necessary for the development of FPTI's from identified relationships between the SOO and performance criteria have been addressed. Second, a variety of theoretical issues involved in the current value approach have been investigated. The statistical methodology associated with the current value approach was extended from a univariate to a multivariate situation. The issues around change scores, especially their reliability, were also addressed. Section 3 dealt primarily with the rationale for and effect of various operations that have been performed on the data set. Most of these operations were not an implicit part of the current value method, but rather the result of an interaction between requirements of the method and the nature of our data set. Finally, in Section 4, we examined how well the assumptions implicit in our linear model are met by the data set. Here it was concluded that a linear model adequately describes the SOO performance relationships for both TVE and ABS. It was also concluded that the number of SOO dimensions included could not be greatly decreased without affecting the ability to predict the criteria. Finally, the examination of the data set revealed the existence of a few data points with extremely large standardized criterion values, and these points were consequently removed from their respective periods.

Simply stated, the result of these analyses, plus those previously reported (Pecorella & Bowers, 1976a, 1976b, 1977) is that we are now able to define the FPTI equations which will be used in the value attribution phase of this study. Table 7 presents values of N, R, and p for the regression of criterion variables (standardized within organizations and across periods) on the 13 SOO predictors (unstandardized) with the data listed in Table 6 deleted from the analysis. Thus, these are the summary characteristics of the FPTI equations for the data from which they were developed. Tables 8 and 9 list the values for the parameters of the FPTI equations, (B_0, B_1, B_2,...B_{13}) for TVE and ABS respectively. These equations will be used to predict changes in future performance from changes in measures of the human organization. Table 10 presents the number of work groups from each organization for which SOO scores at T_0 and T_0' are available. Thus, the FPTI equations represented in Tables 8 and 9 will be applied to the SOO change scores for these work groups.[2] The predicted changes in performance thus computed will then be converted to dollar values and discounted to present value.

The theoretical issues discussed ranged from those involved in the development of the FPTI's in this study to those which, while not of direct concern in this study, are of importance in any implementation of a current value human resources accounting system. Taken as a whole, the analyses

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[2]The ABS and TVE FPTI's were developed using data from data from different organizations and in some cases from different sites of the same organizations. Since the TVE and ABS FPTI's will each be applied only to the subgroup of organizations and sites on which they were developed, some organizations have different numbers of groups with T_0 and T_0' SOO scores for the ABS and TVE FPTI value attribution, as shown in Table 10.

Table 7

VALUES OF N, R, AND p FOR THE REGRESSION EQUATIONS USED TO DEFINE FPTI'S

	TVE									
	A	B	C	D	E	F	G	H	I	
N	188	127	442	505	442	198	51	45	409	
R	.51	.34	.39	.28	.27	.52	.57	.57	.28	
p	.01	.35	.01	.01	.01	.01	.23	.35	.01	
	ABS									
	A	B	C	D	E	F	G	H	I	J
N	254	389	434	121	434	351	336	289	266	266
R	.47	.40	.31	.40	.30	.33	.34	.42	.56	.45
p	.01	.01	.01	.10	.01	.01	.01	.01	.01	.01

Table 8

BETA WEIGHTS FOR PERIOD FPTI'S OF TVE

	A	B	C	D	E	F	G	H	I
Regression Constant	.00247	.16430	.49197	1.0669	.94343	-.83179	-.71201	.60534	.57522
Supervisory Support	-.18483	-.01911	-.17555	-.04021	-.02063	.24337	-.29418	-.29767	-.07030
Supervisory Goal Emphasis	.11443	.11000	.20353	.24248	.16684	.10592	-.12580	-.43941	.04352
Supervisory Work Facilitation	.11195	.12490	-.00630	-.06977	-.02334	.15926	.34966	.32313	.10334
Supervisory Team Building	.12577	-.21590	.02611	.00948	-.06070	-.48260	-.06603	.49962	-.10963
Peer Support	.39078	.03359	-.15249	-.09380	-.10912	.25140	.08940	.29487	-.08029
Peer Goal Emphasis	-.12371	.13237	-.24554	-.25009	-.11746	.42923	.15495	-.14403	-.31091
Peer Work Facilitation	-.43689	-.36955	-.05815	-.19456	-.12499	-.97722	-.04795	-.31268	-.19232
Peer Interaction Facilitation	-.09009	.18499	.44040	.38398	.36051	.51046	-.19970	.13590	.57676
Human Resources Primacy	-.08535	-.09361	-.16294	-.16463	-.36936	.56292	.23469	-.01118	-.17215
Communication Flow	-.26790	-.18887	-.38943	-.48789	-.25253	.14878	.08824	.12399	-.15804
Motivational Conditions	-.12977	-.20126	-.01472	.22501	.19181	-.19849	.02421	-.37802	.08388
Decision Making Practices	-.35838	-.12199	.02672	.02686	.05695	-.90434	-.20198	.15358	.20576
Satisfaction	.62770	.40399	.33829	.03748	-.00535	-.03477	.15442	-.08274	-.07647

Table 9

BETA WEIGHTS FOR PERIOD FPTI'S OF ABSENCE

	A	B	C	D	E	F	G	H	I	J
Regression Constant	1.5179	.49961	1.0282	1.0352	.22473	1.0094	.67690	.45852	-1.0411	.30370
Supervisory Support	-.48979	-.09379	-.35387	-.12286	-.09911	.14929	-.21582	-.07133	.39141	-.22864
Supervisory Goal Emphasis	.04810	.18358	.12241	-.21631	.36472	.14842	.16558	-.07054	.05707	-.00076
Supervisory Work Facilitation	.15065	.05978	.18522	.27108	-.46797	-.11026	.01772	.13328	-.16584	.13054
Supervisory Team Building	.10312	-.20706	-.04771	.07458	.19924	-.06599	.11636	-.02617	-.20138	.08197
Peer Support	-.56715	.27172	-.17250	-.09903	.14298	.17288	-.06851	-.17588	.46732	-.20608
Peer Goal Emphasis	.06387	-.13370	-.27301	.02057	-.19864	-.01931	.24858	-.11328	.02489	.04345
Peer Work Facilitation	.18083	-.62019	-.25236	.18299	.30477	.16537	.28413	-.13064	-.12974	-.02875
Peer Interaction Faciliation	.52212	.44863	.44706	-.25277	-.27005	-.27351	-.15285	.50633	-.36227	.23559
Human Resources Primacy	-.28960	.03289	-.02992	-.16707	-.37616	-.12823	-.12451	-.18422	.01404	-.16442
Communication Flow	-.18017	.25347	.06572	.30429	-.10363	.02381	-.29979	-.11554	.41686	-.07937
Motivational Conditions	.12527	-.18171	-.24122	-.13253	.46093	.04377	.19541	-.09696	-.03654	.14282
Decision Making Practices	-.30246	-.22958	-.12186	-.08815	.44863	-.18535	-.32057	-.11913	.33242	-.10209
Satisfaction	.33982	-.16062	.32023	-.02681	-.26313	-.21633	.03280	.20076	-.62103	.01809

Table 10

WORK GROUPS WITH T_o AND T_o' SOO SCORES

		TVE	ABS
Organization	I	--	27
	II	233	233
	III	176	176
	IV	115	--
	VI	246	197
	Total	770	633

presented herein allow us to move forward to the value attribution phase in the present study and to remain aware of issues of potential concern in an actual FPTI implementation.

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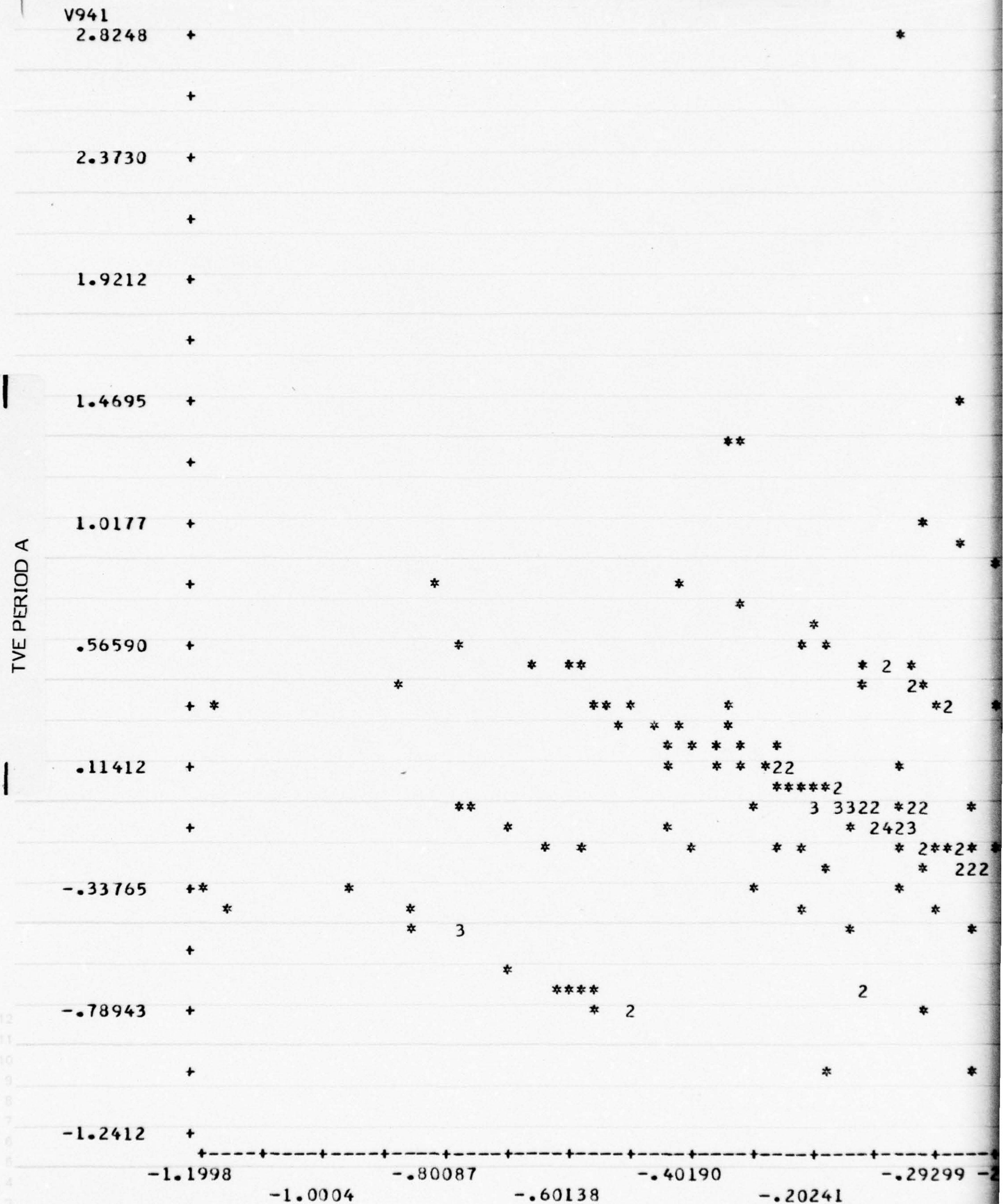
APPENDIX A

SCATTER DIAGRAMS OF RESIDUAL VS. PREDICTED VALUES FOR TVE PERIODS A-I AND ABS PERIODS A-J.

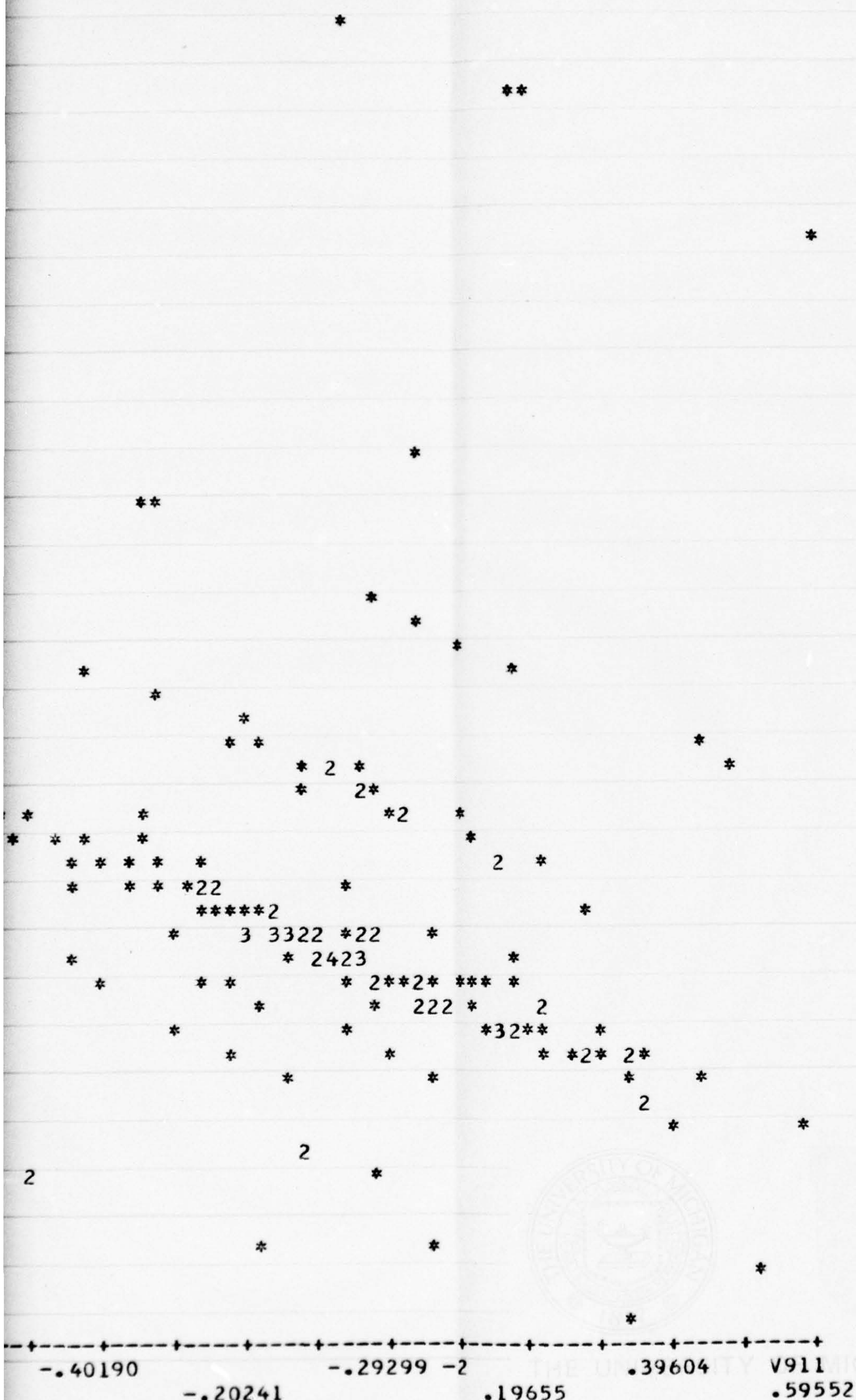
SCATTER PLOT



1

A-2

2



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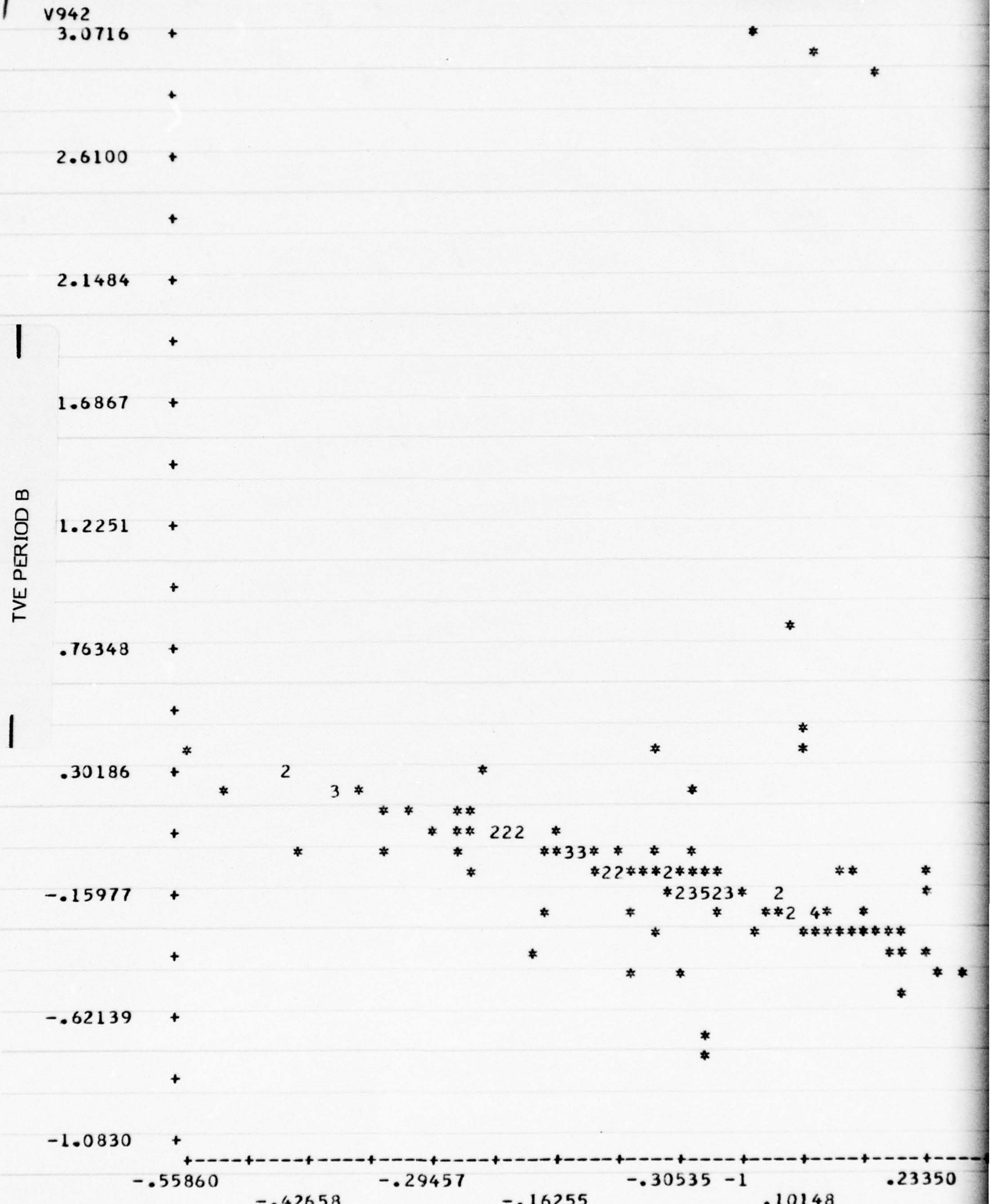
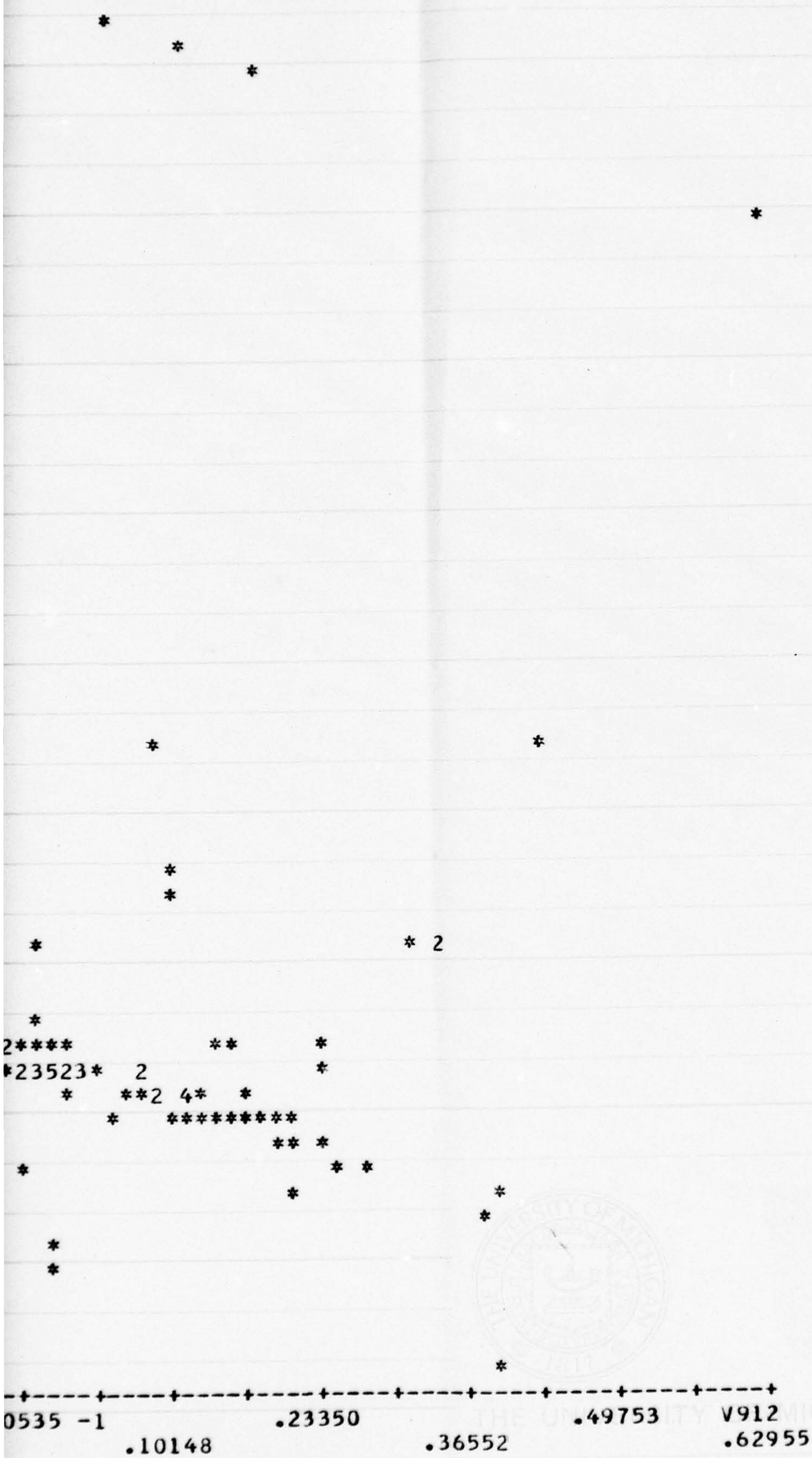


A-3

2



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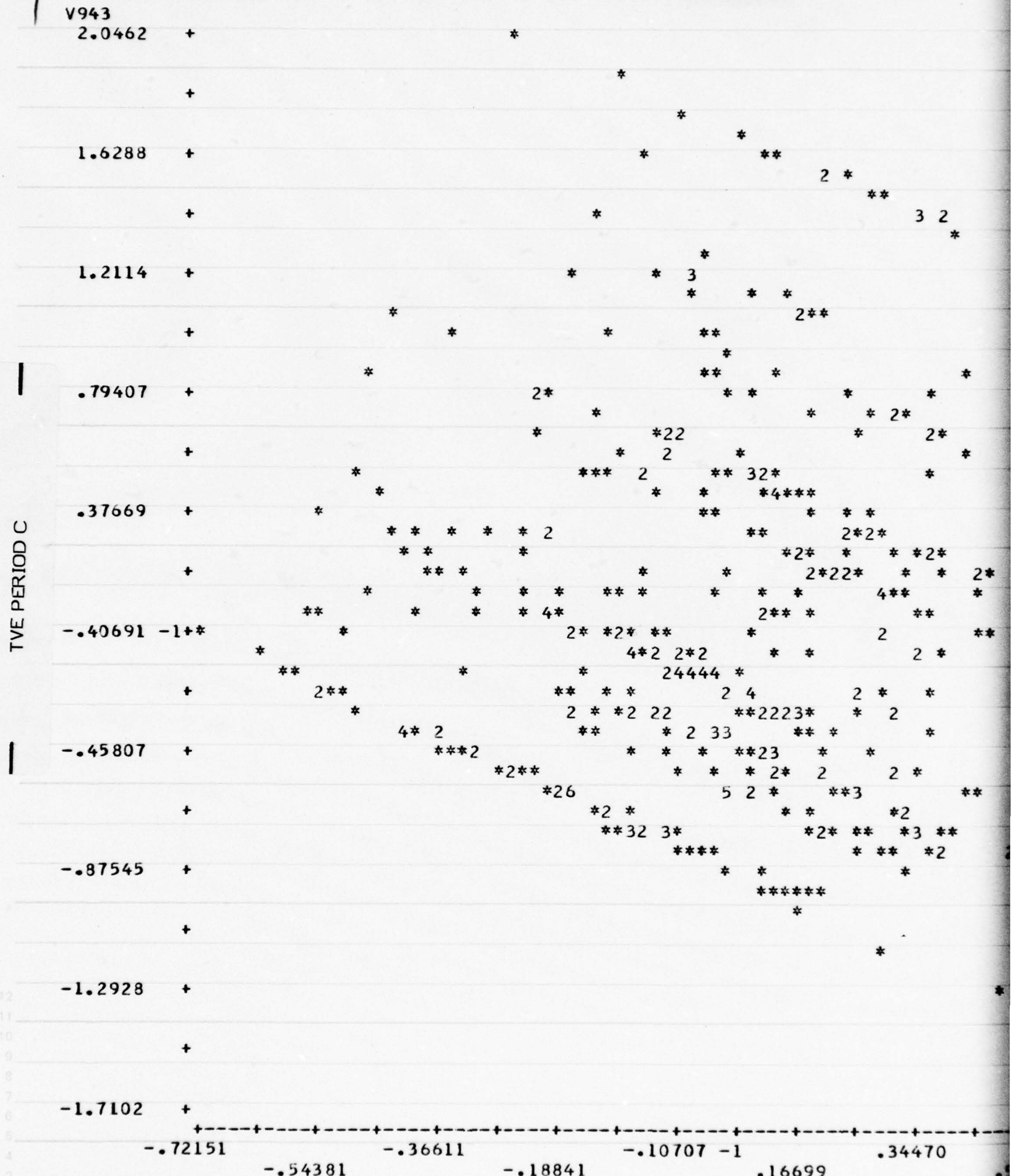

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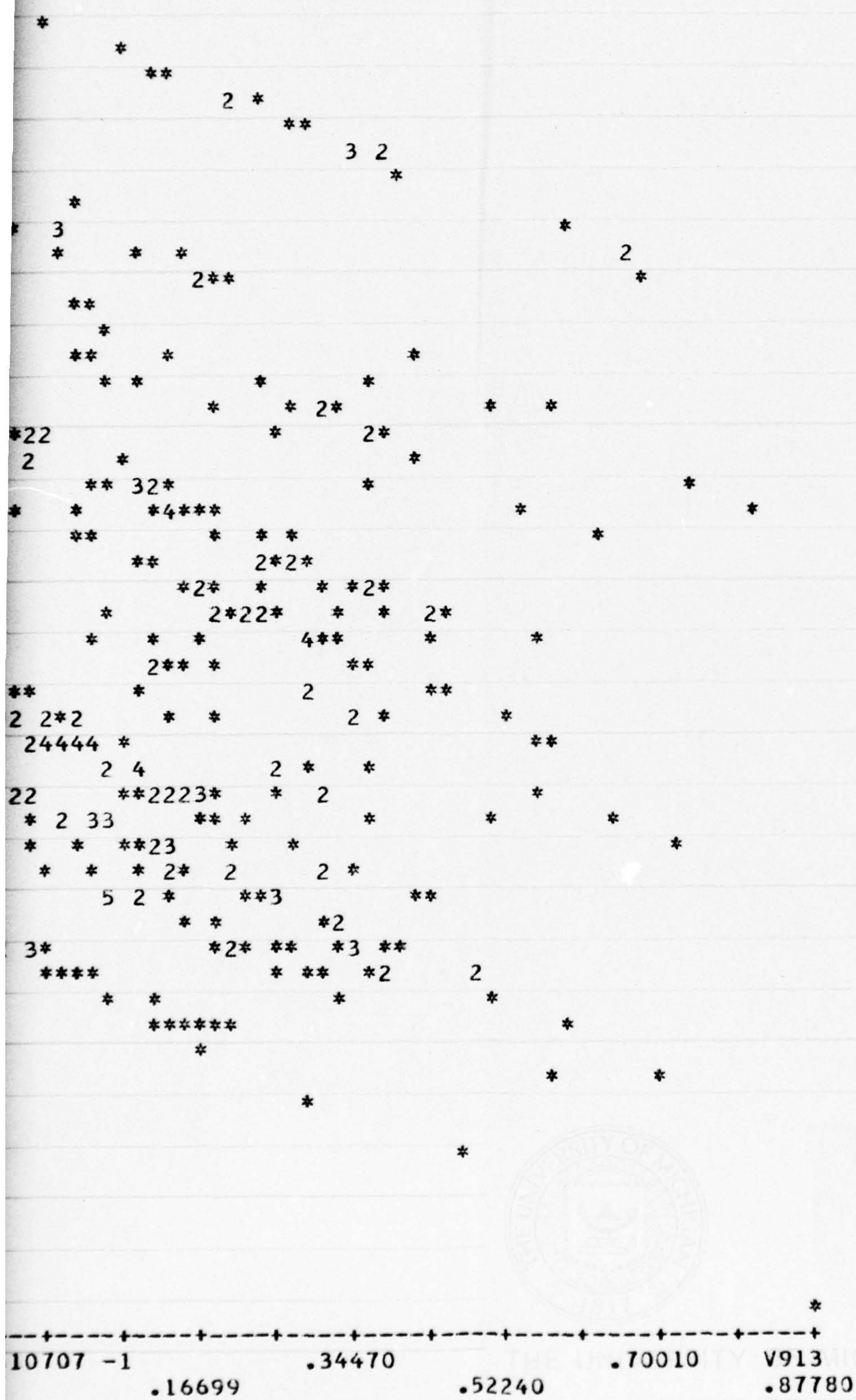
2



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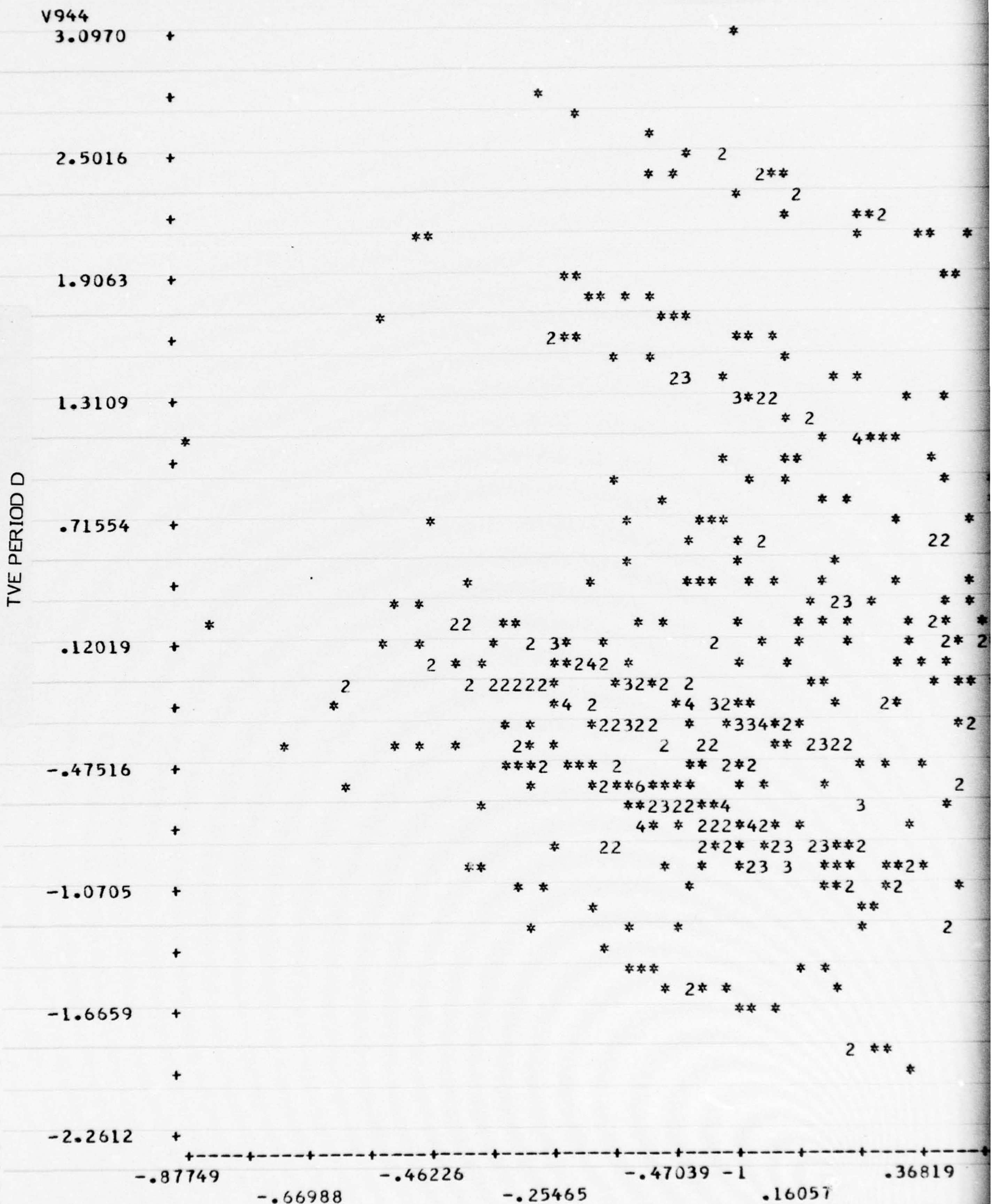

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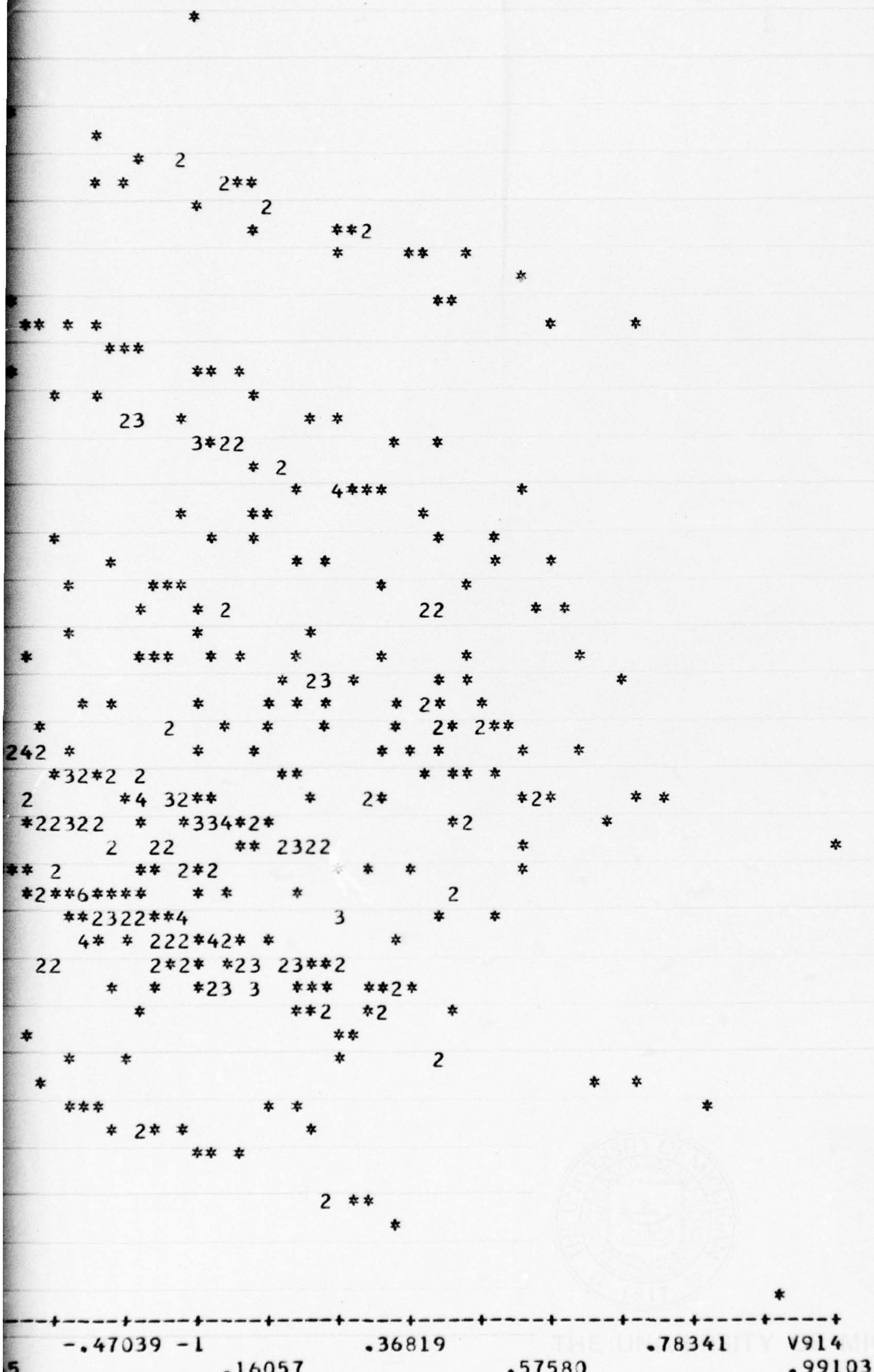

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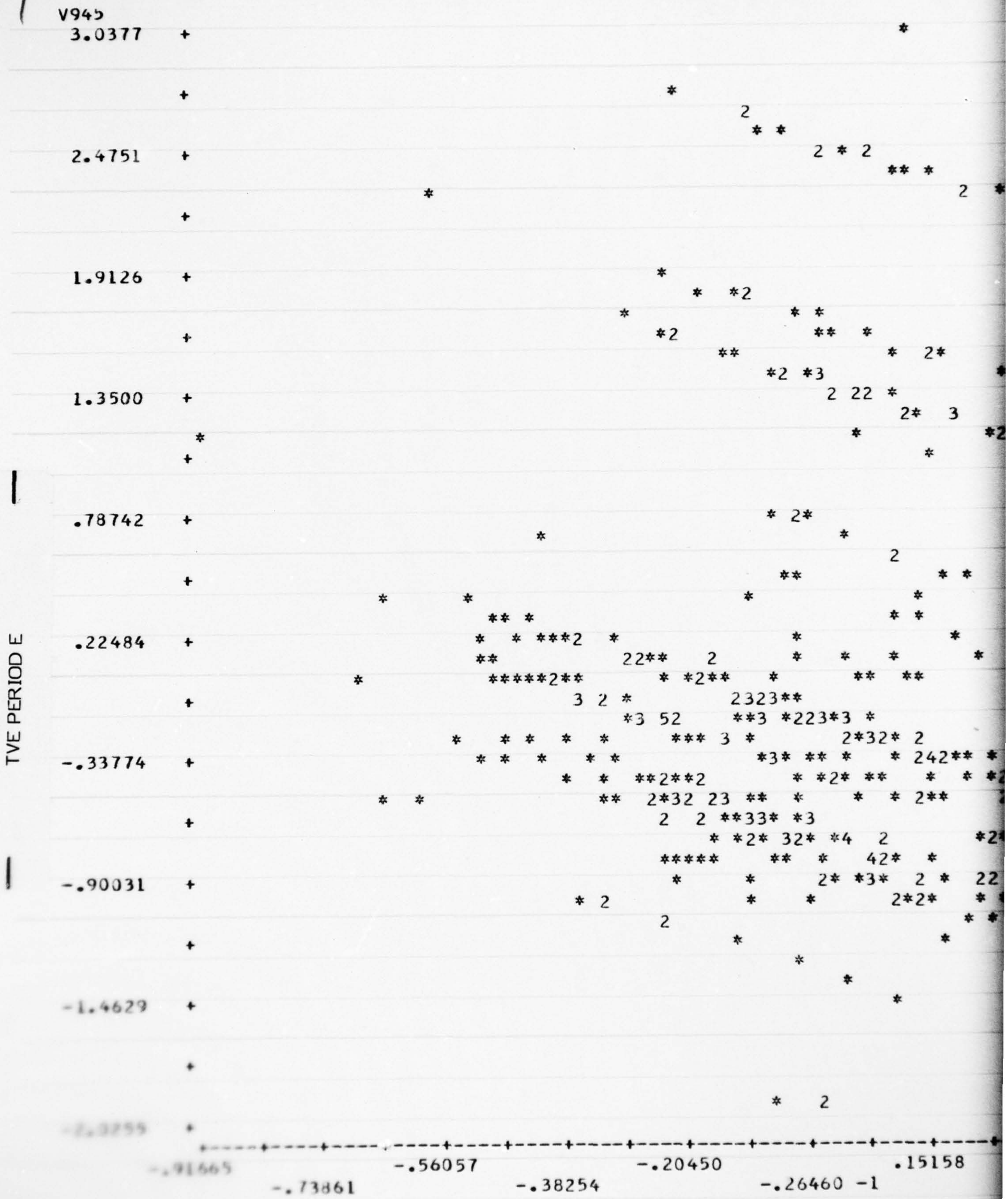

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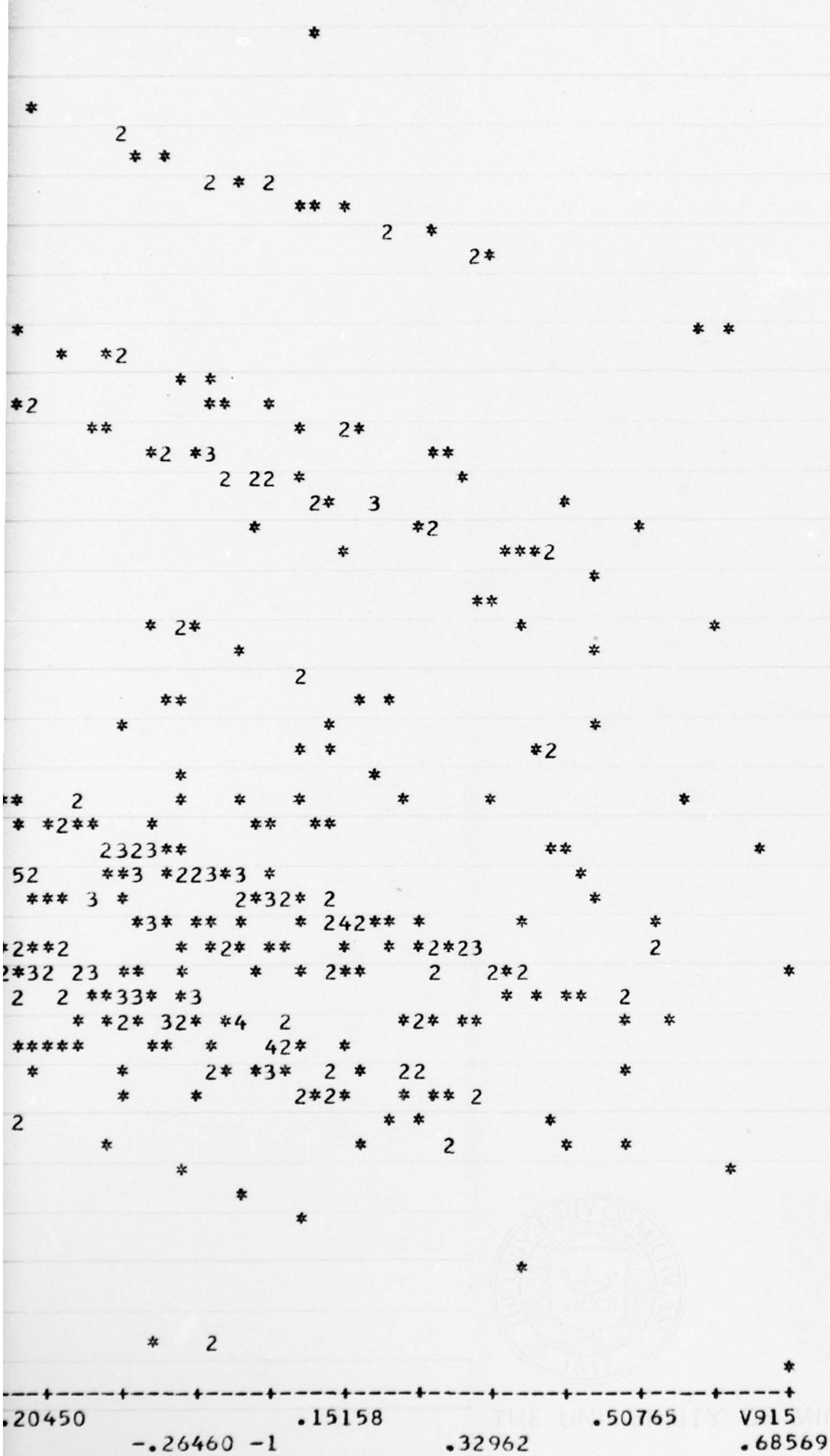

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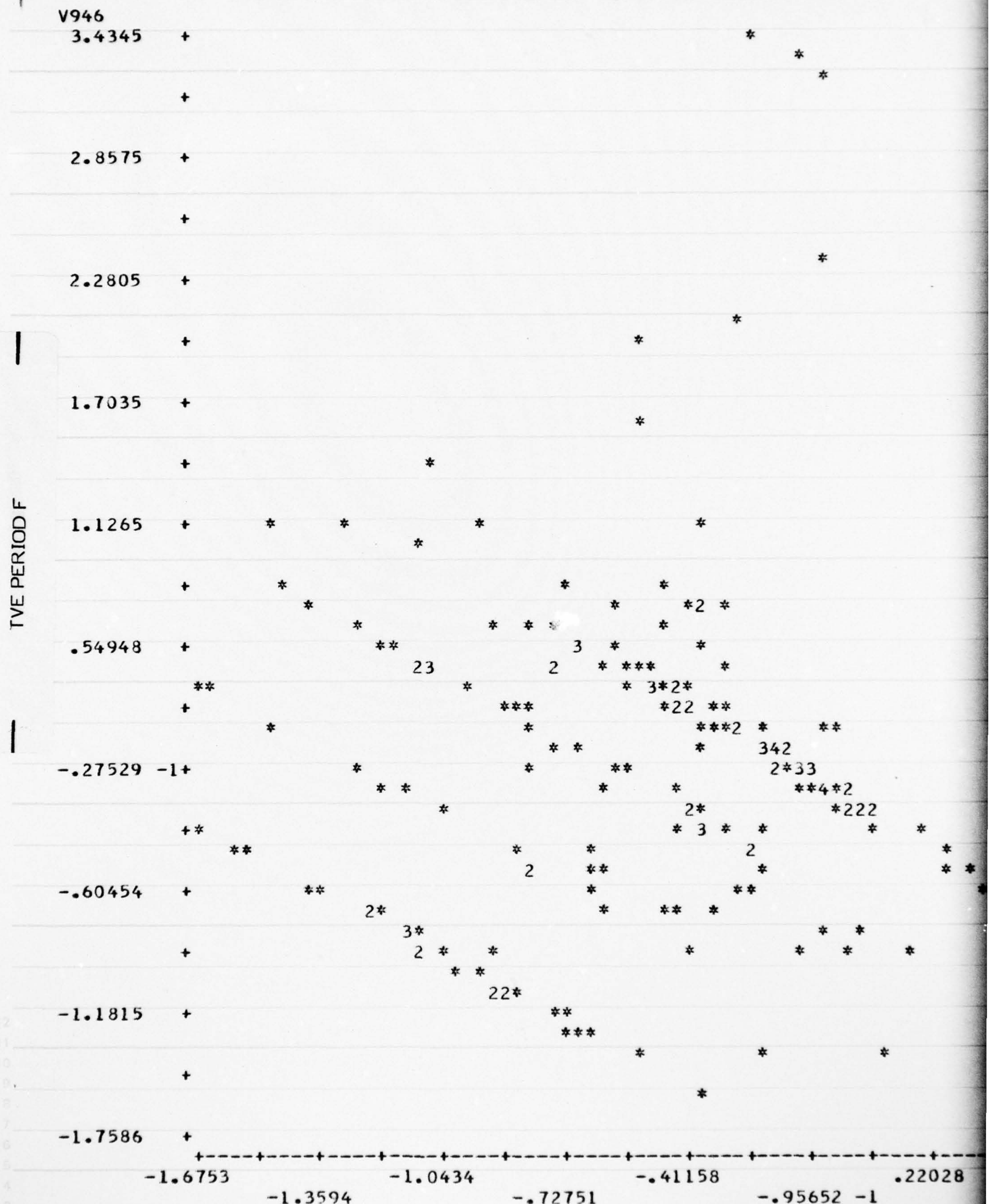

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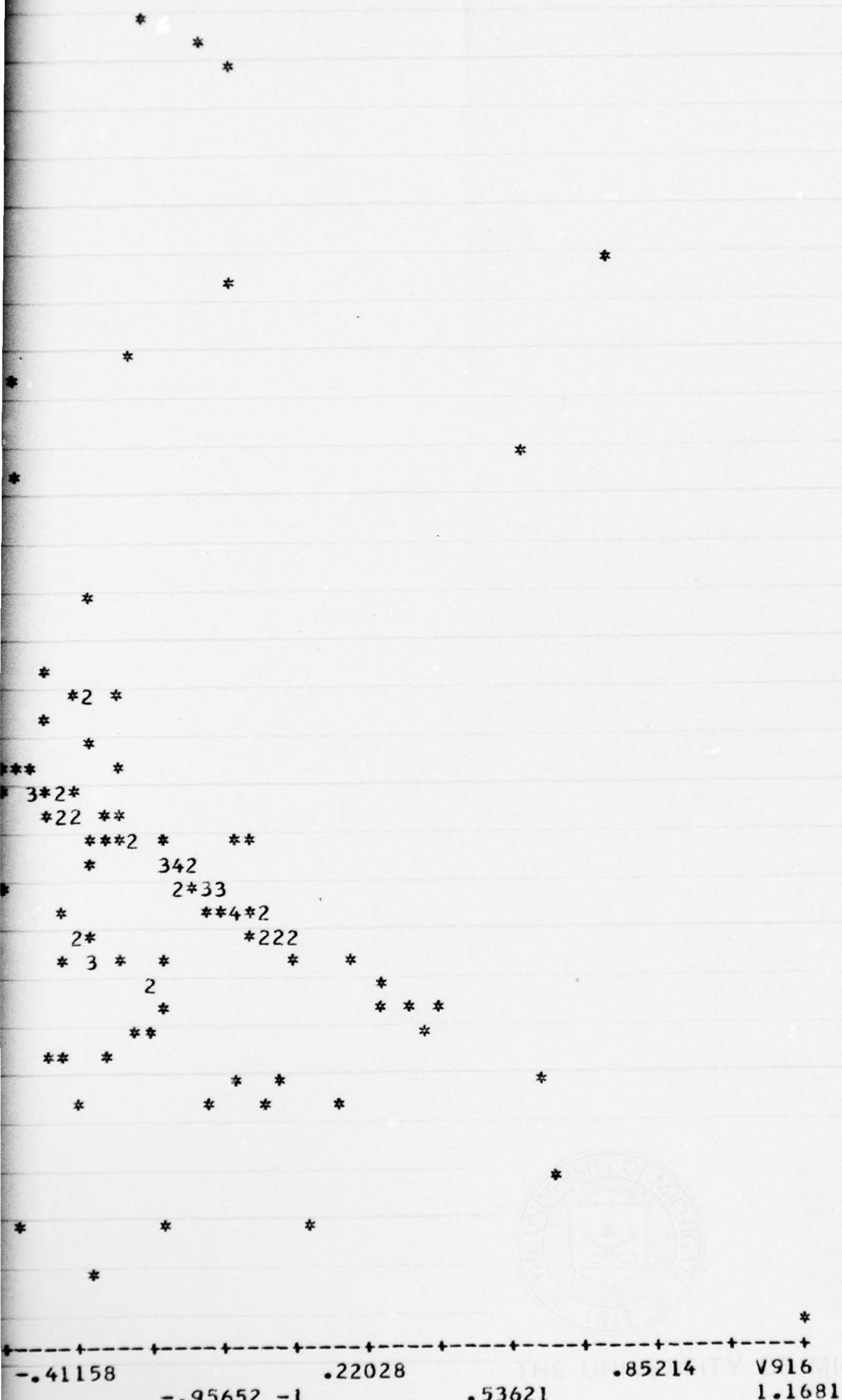

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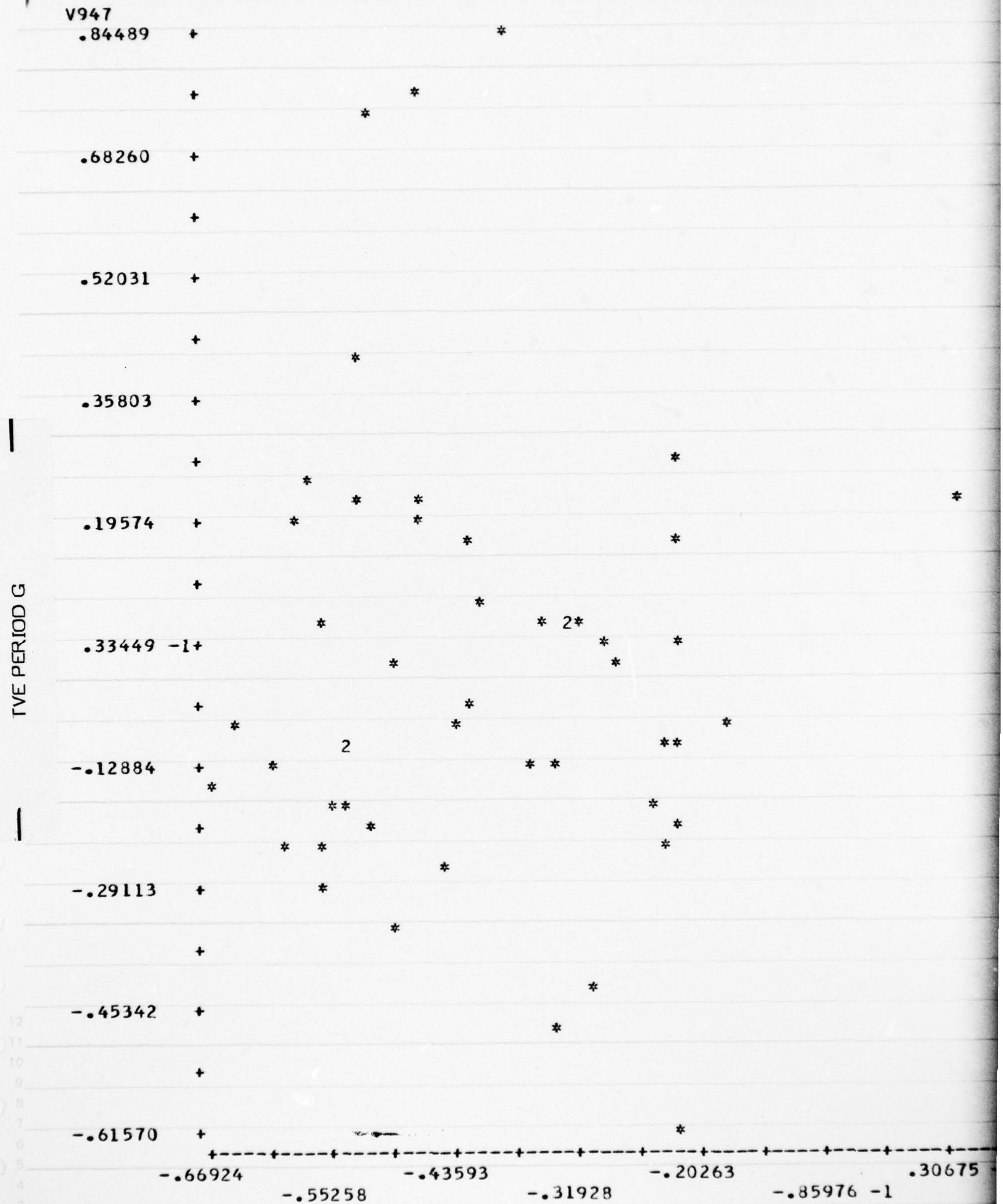

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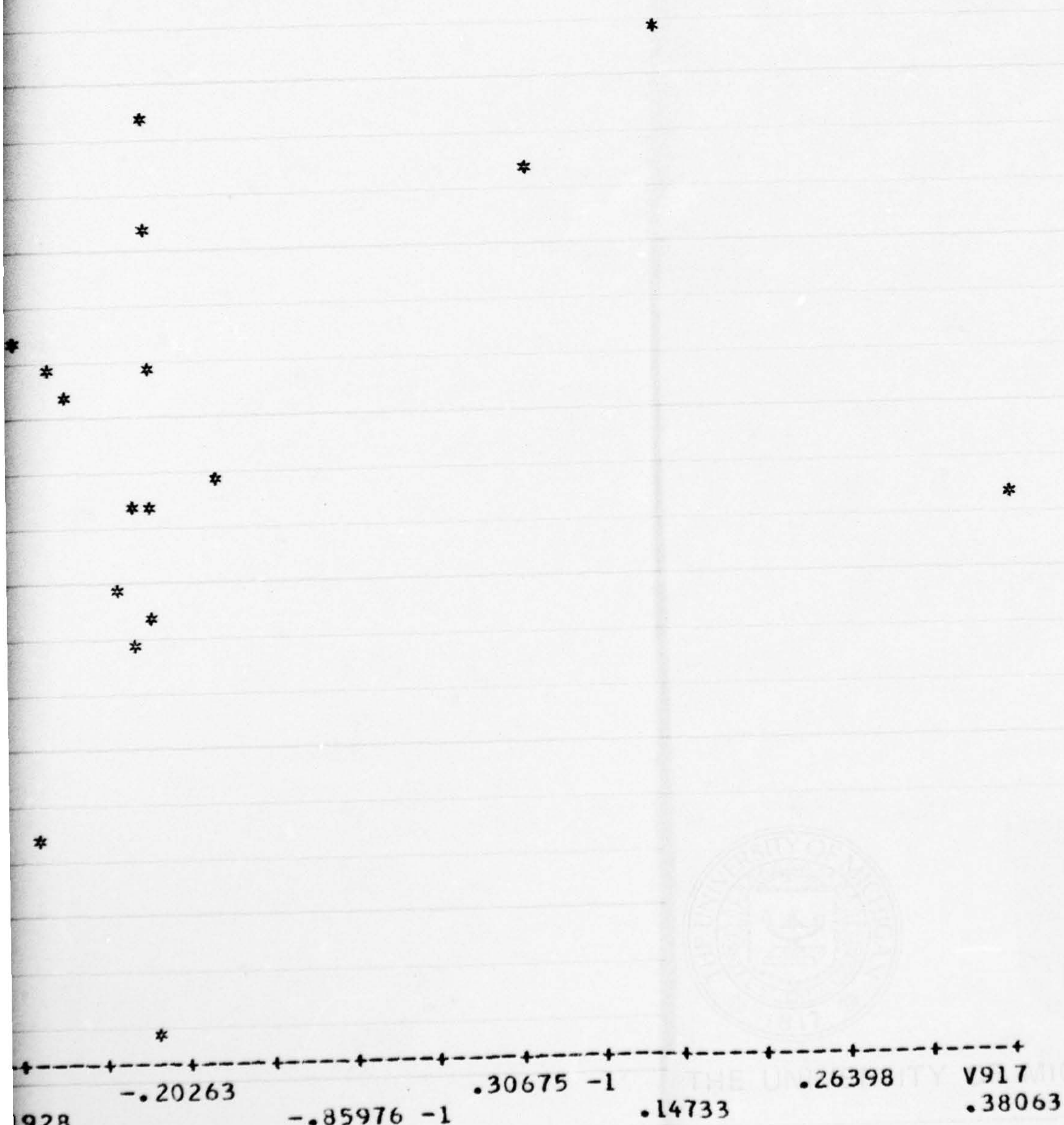

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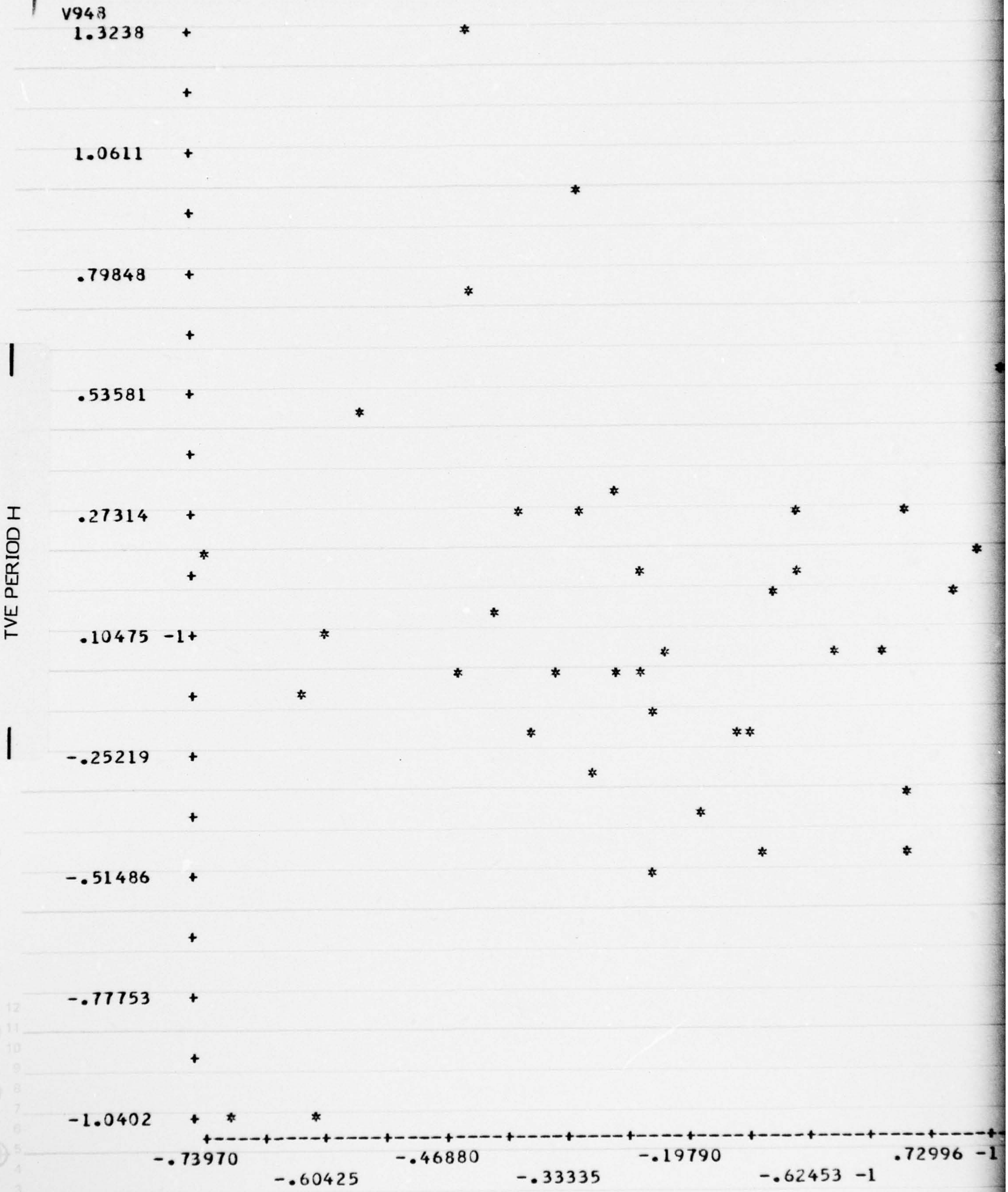

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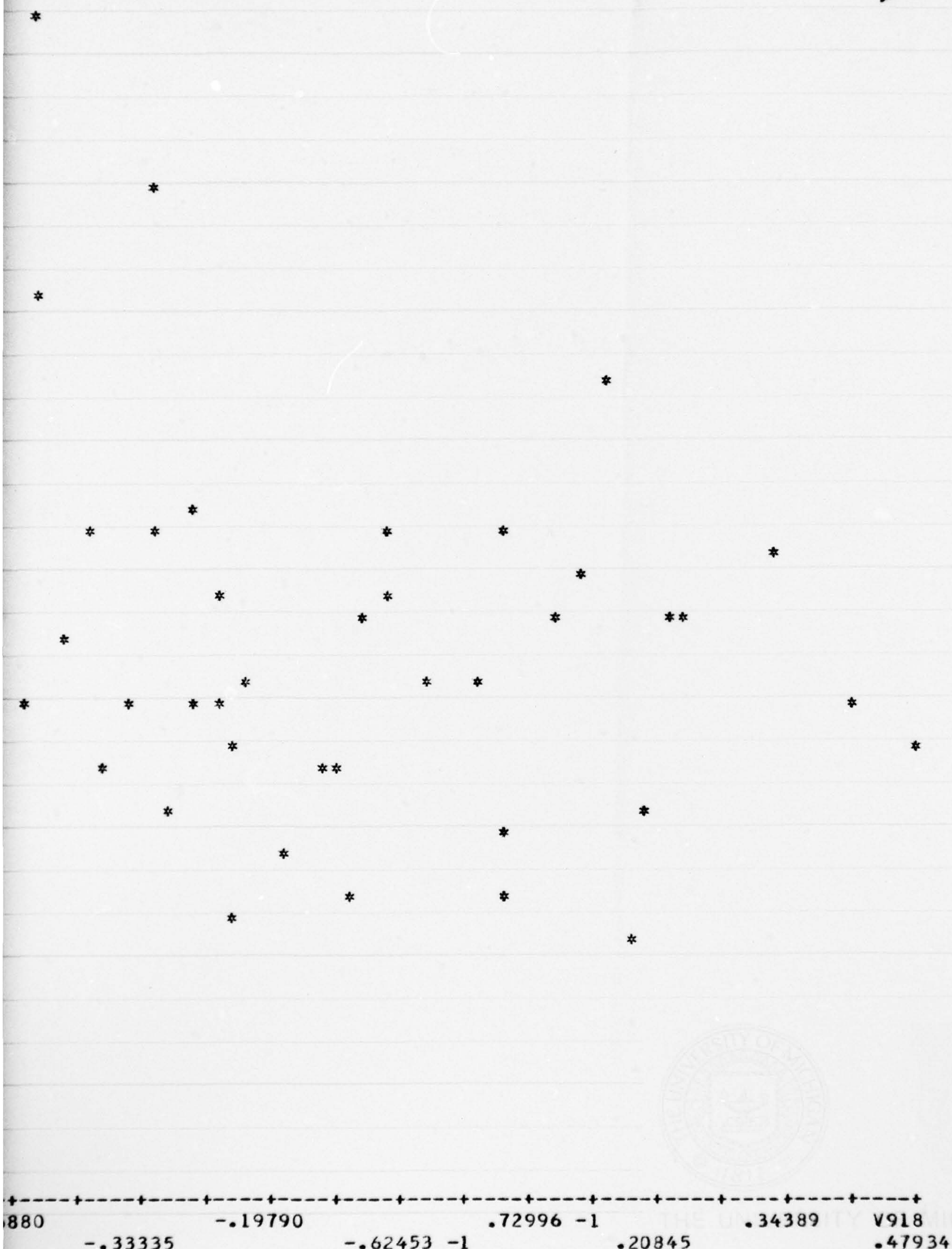

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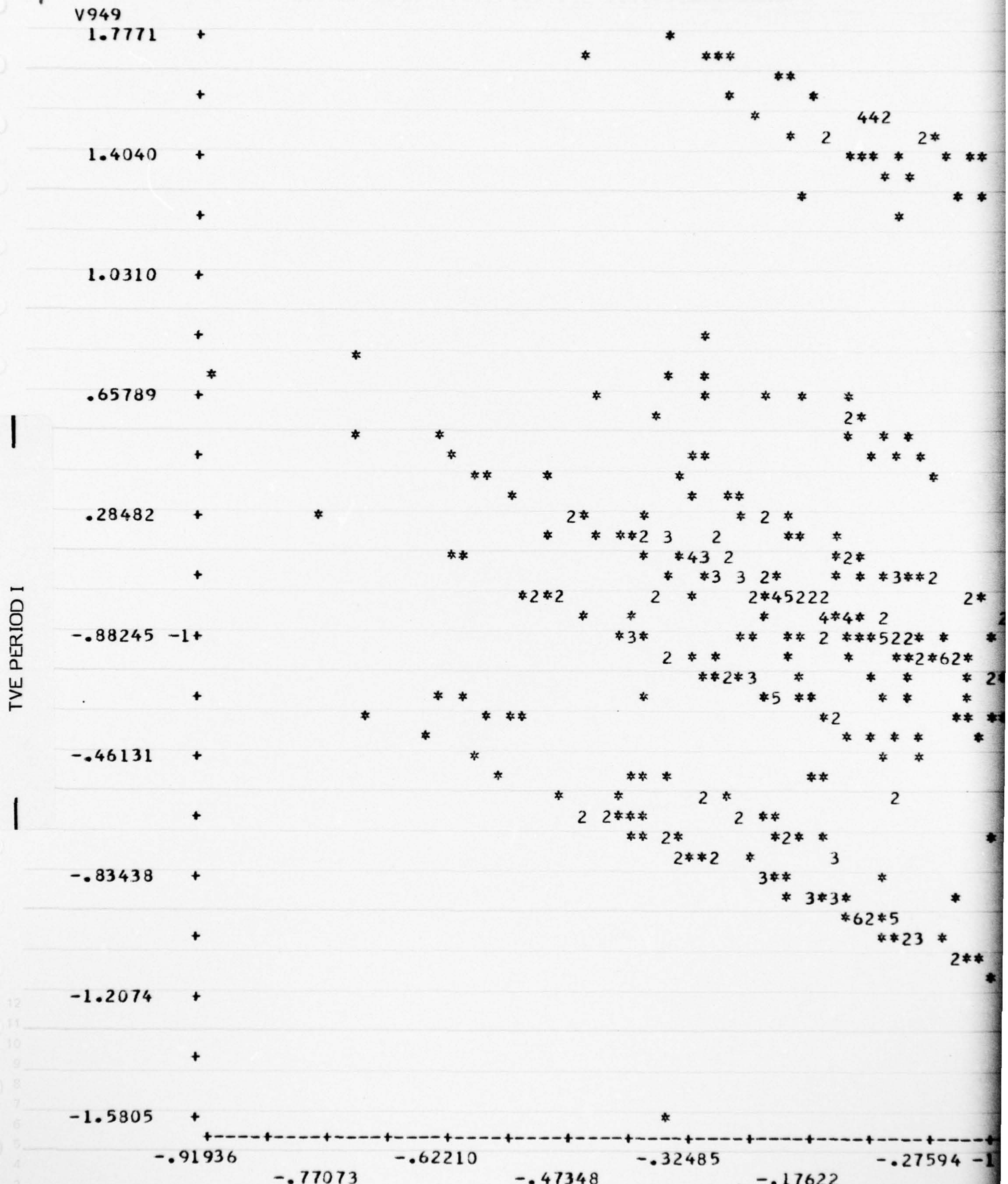

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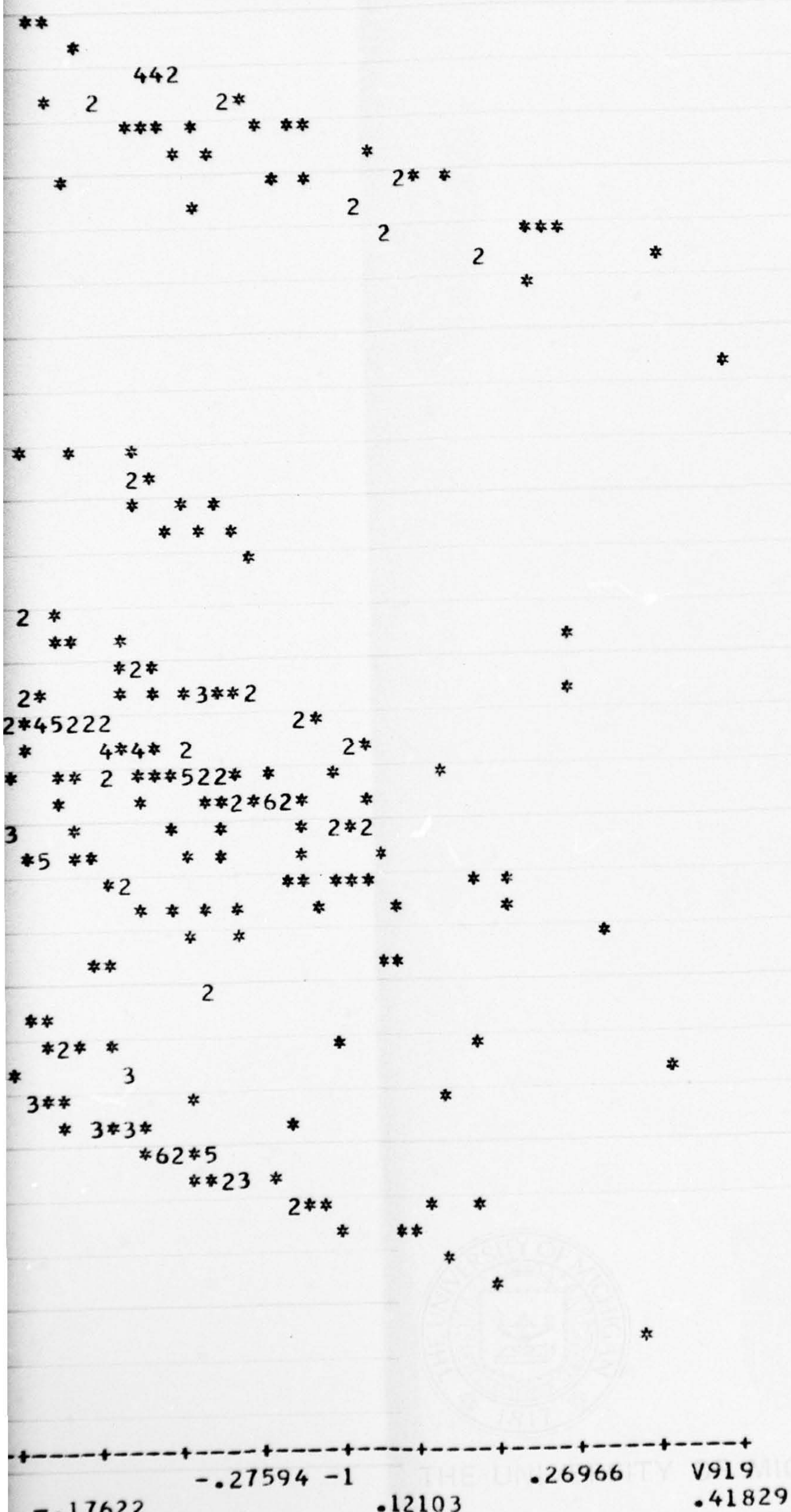

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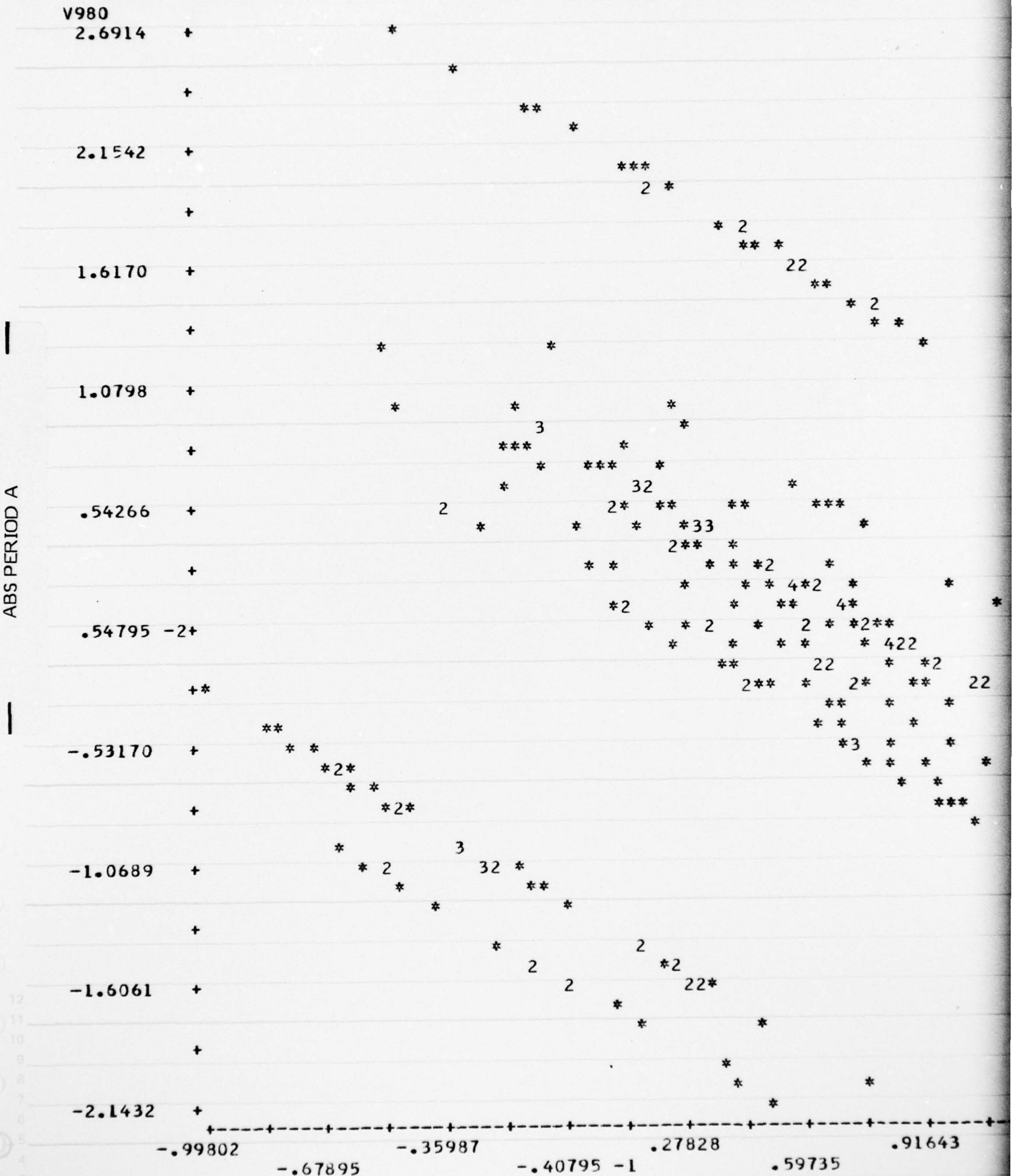

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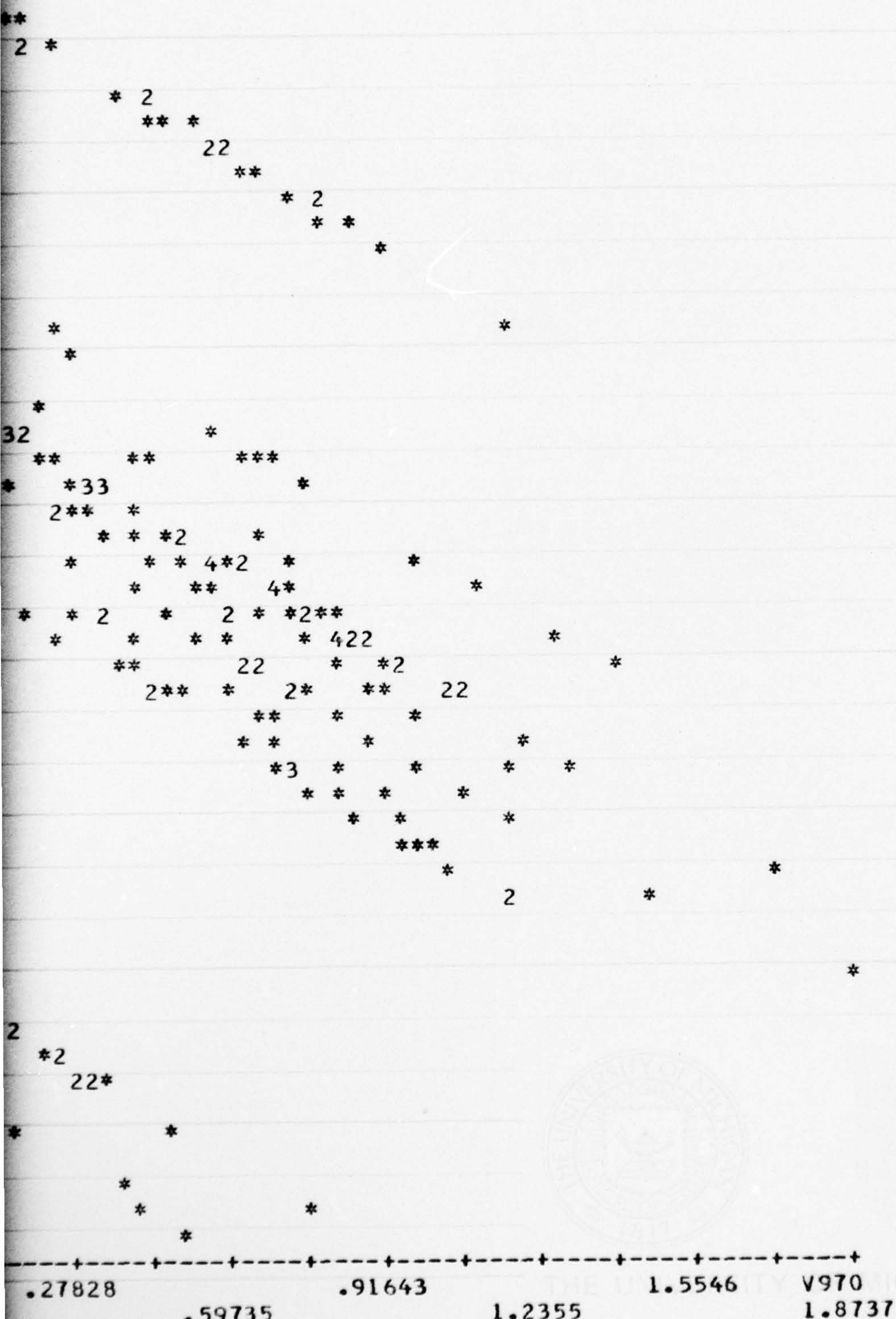

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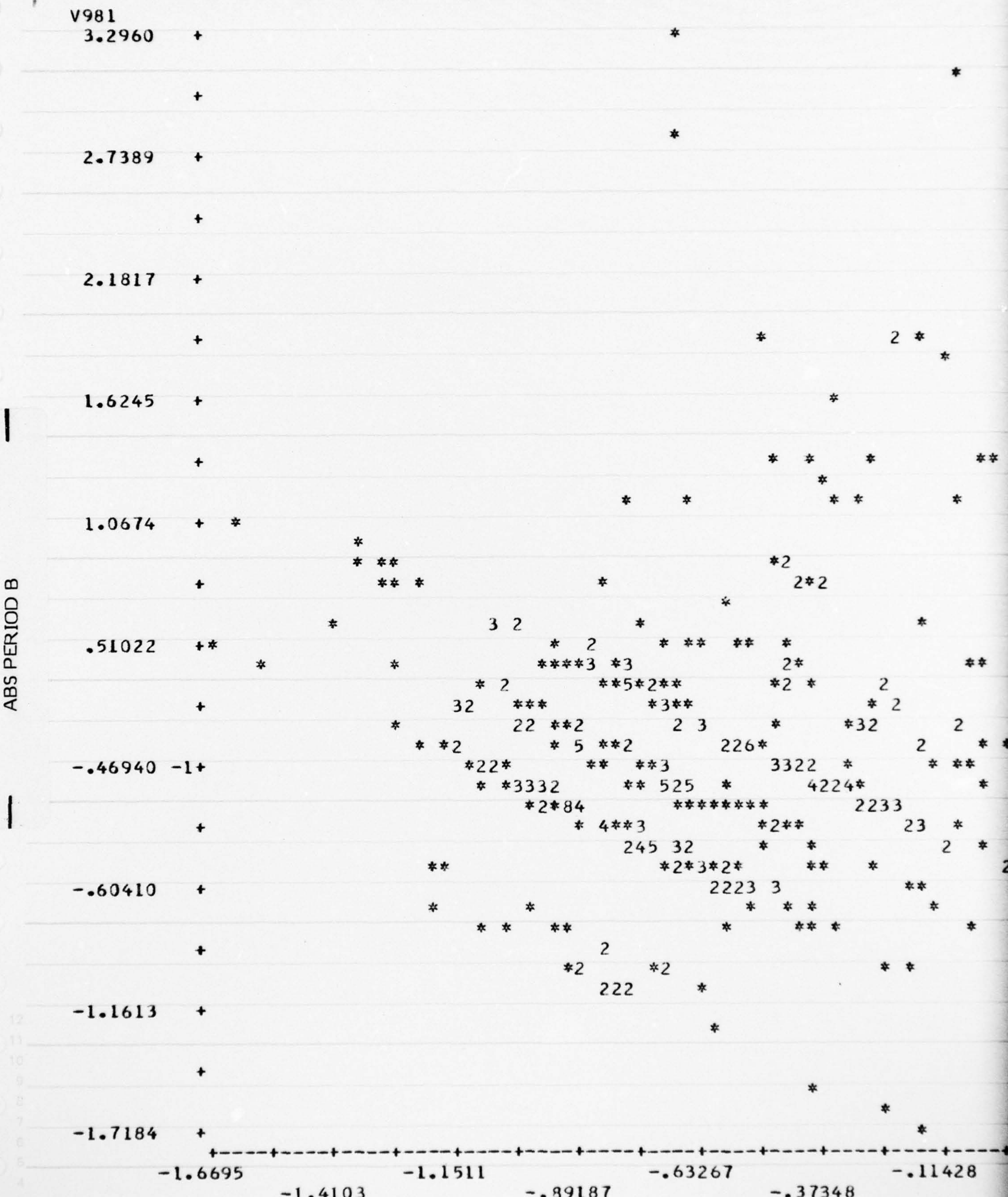

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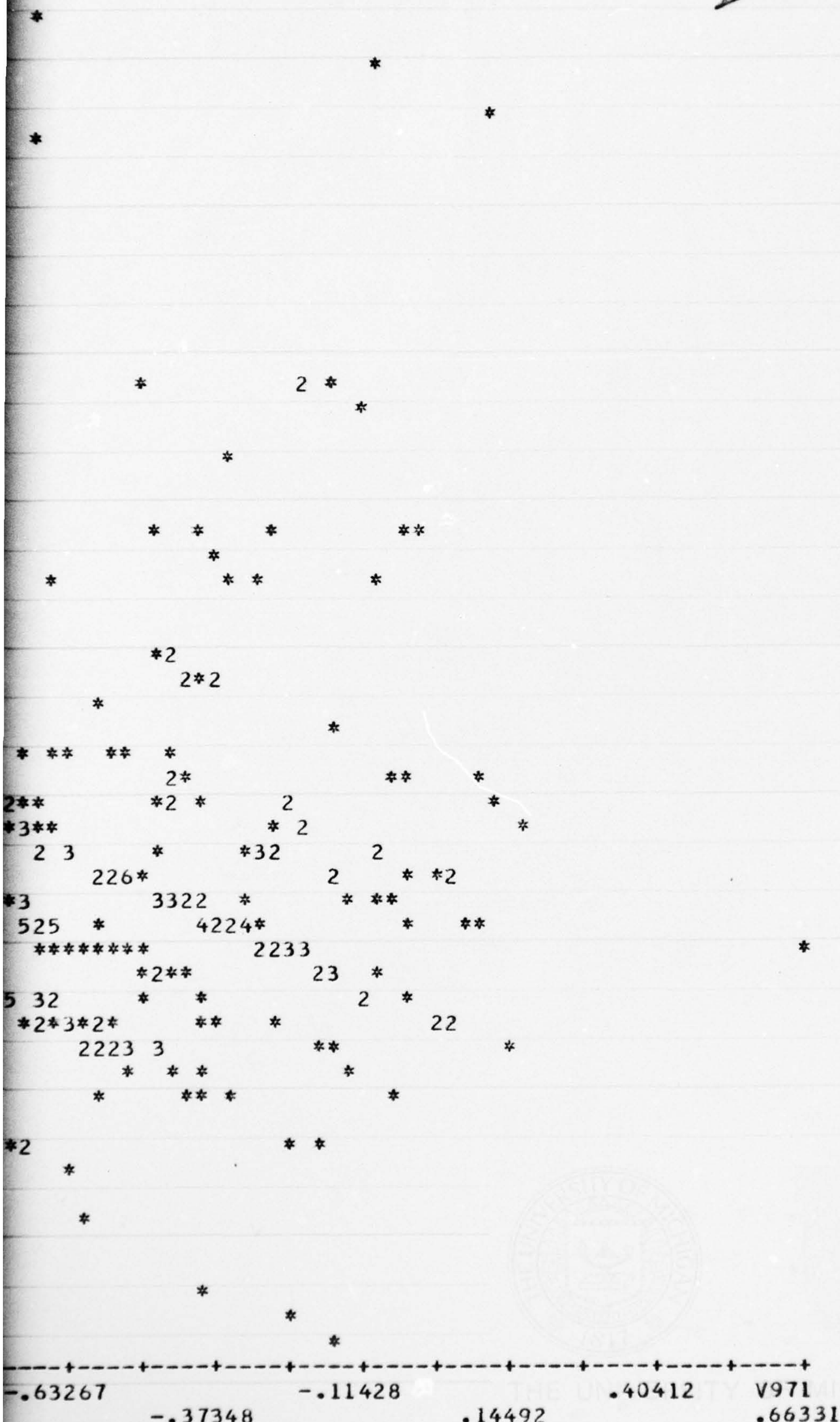

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FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH T--ETC(U)
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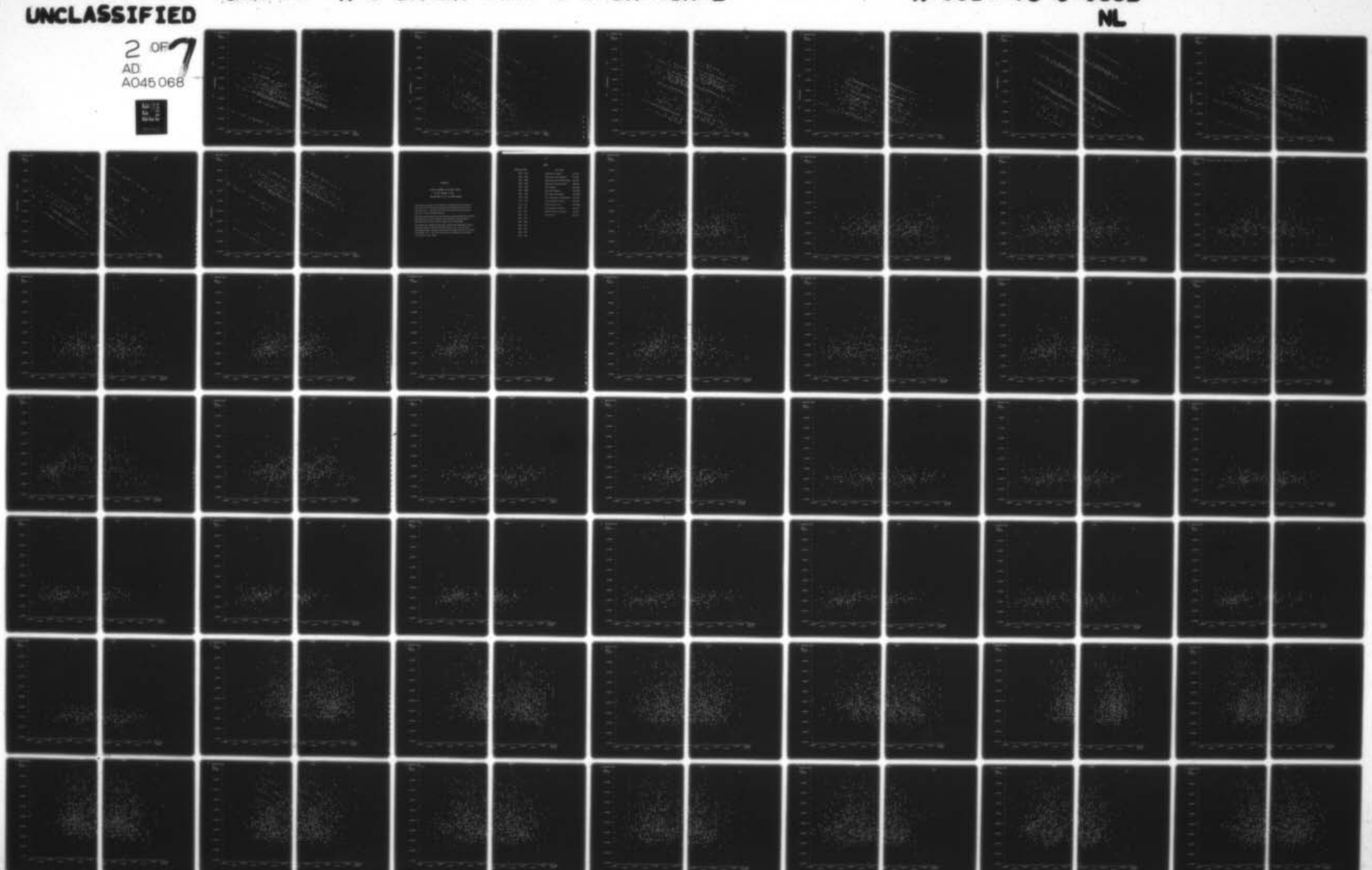

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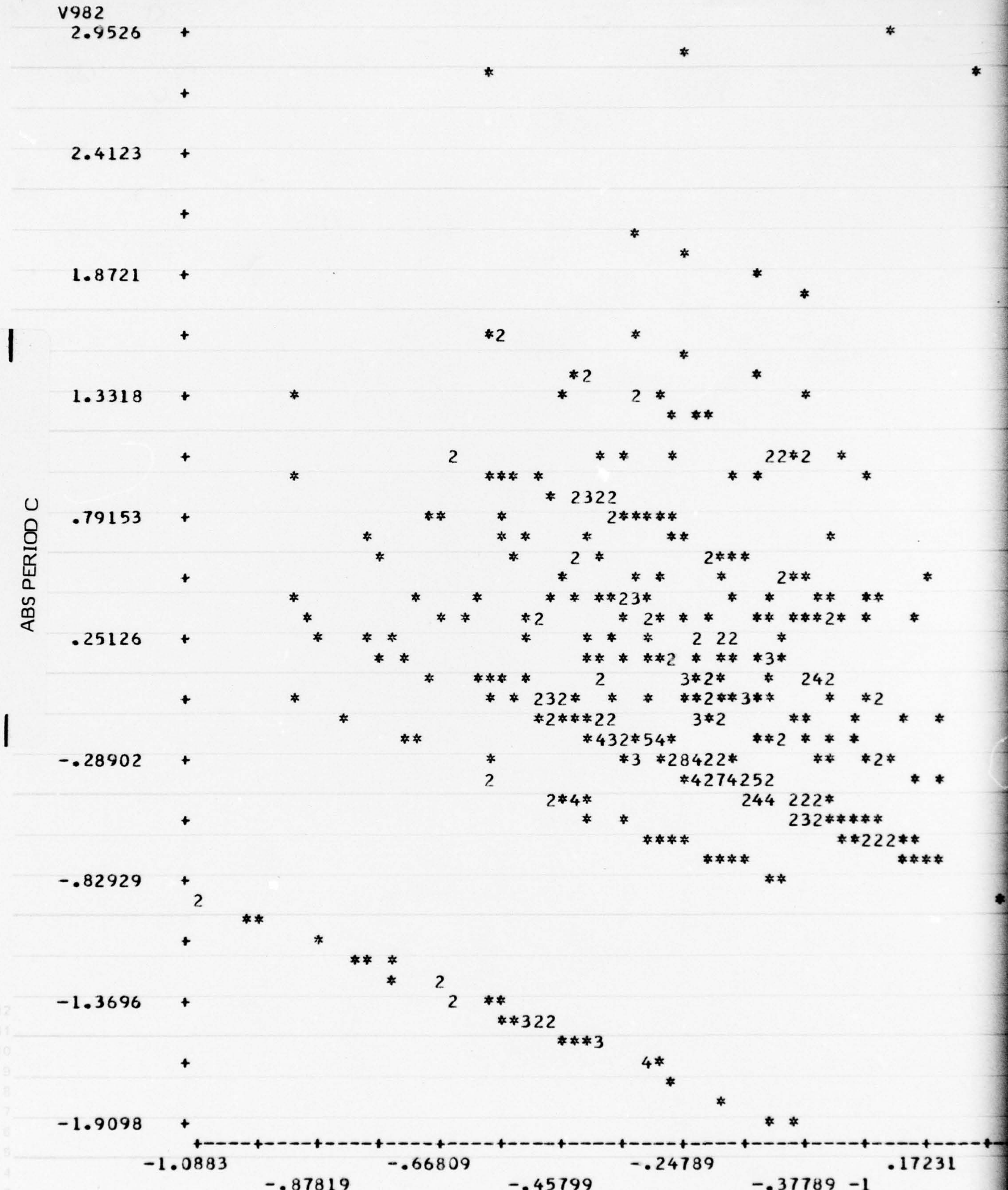

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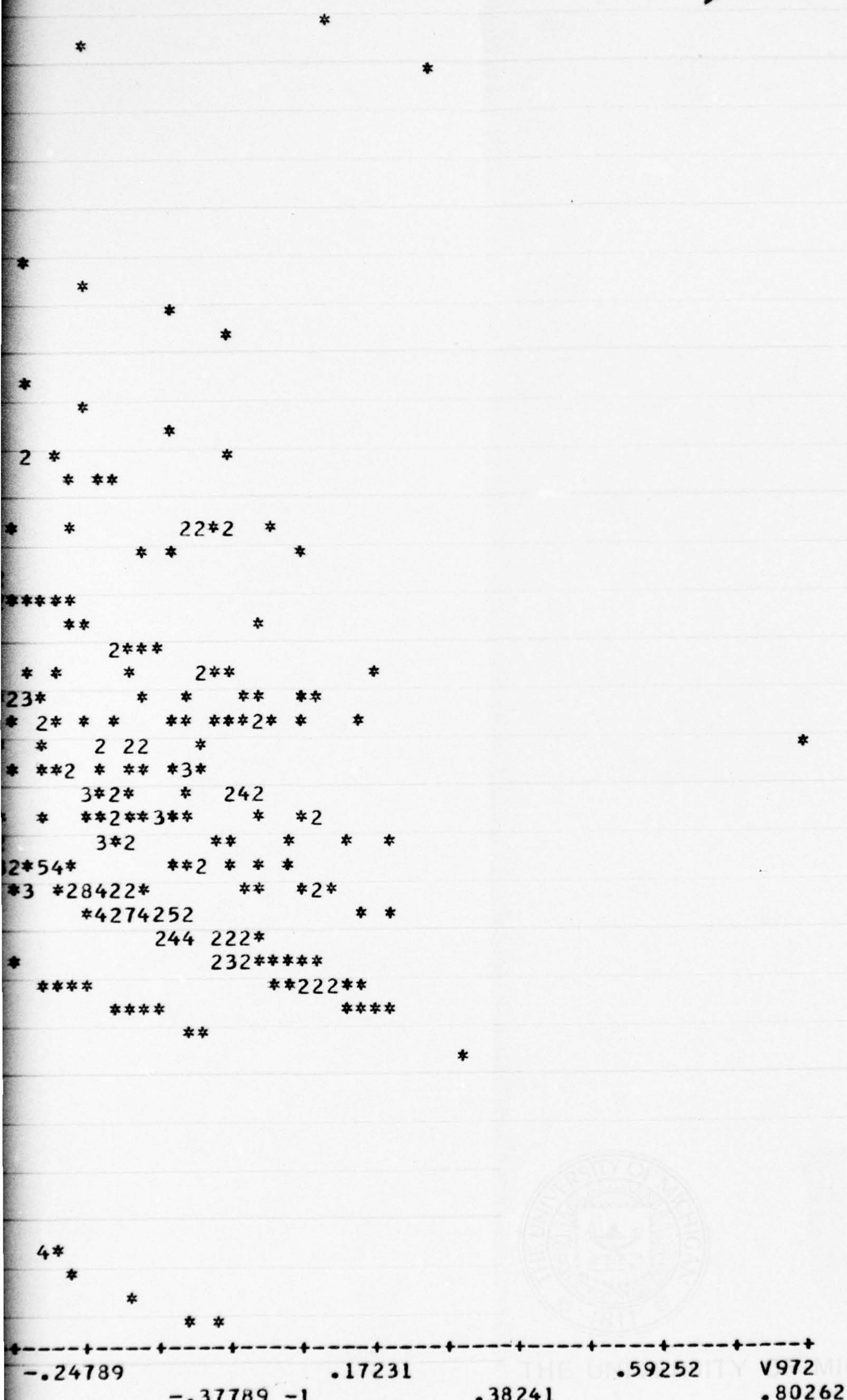

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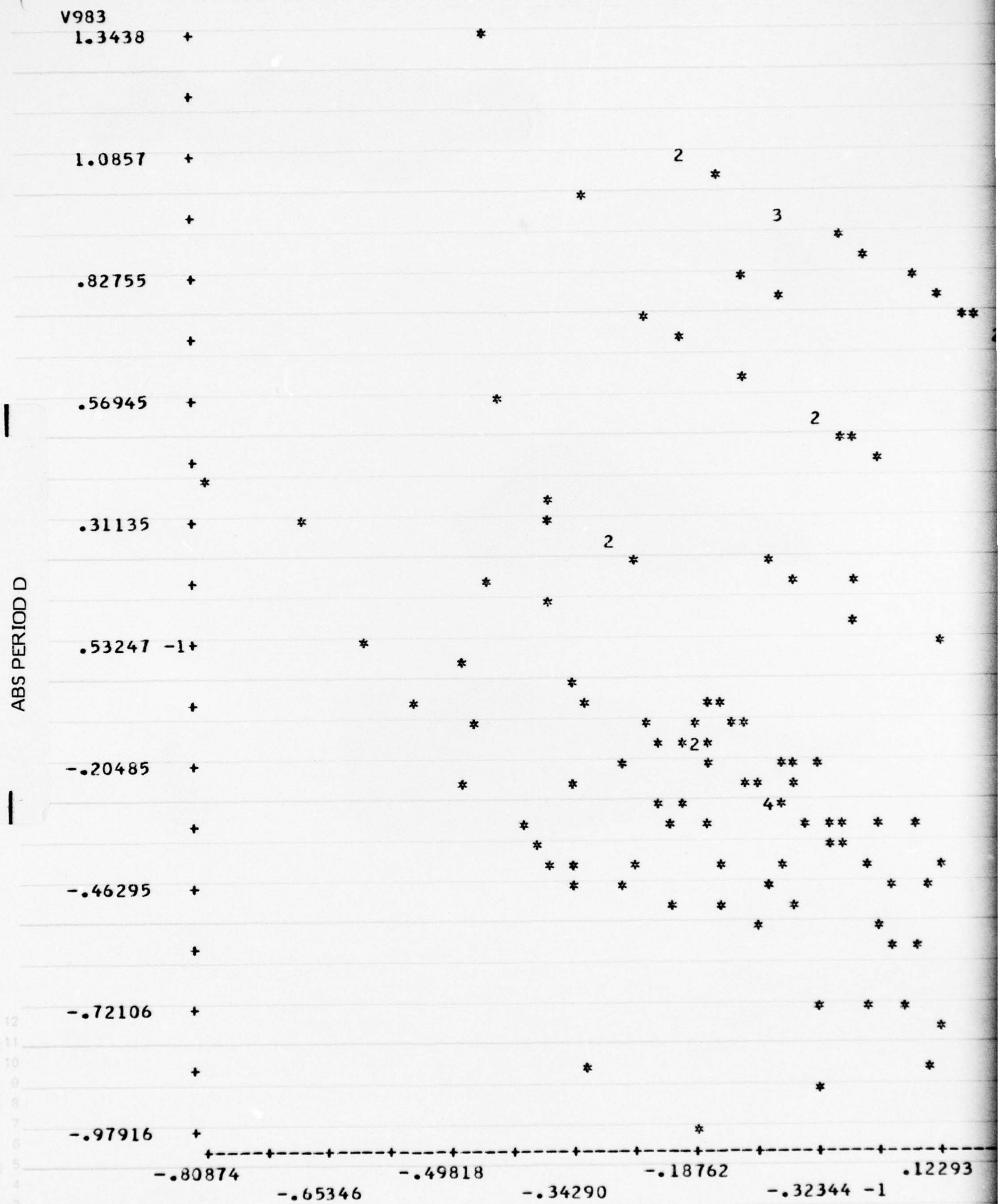

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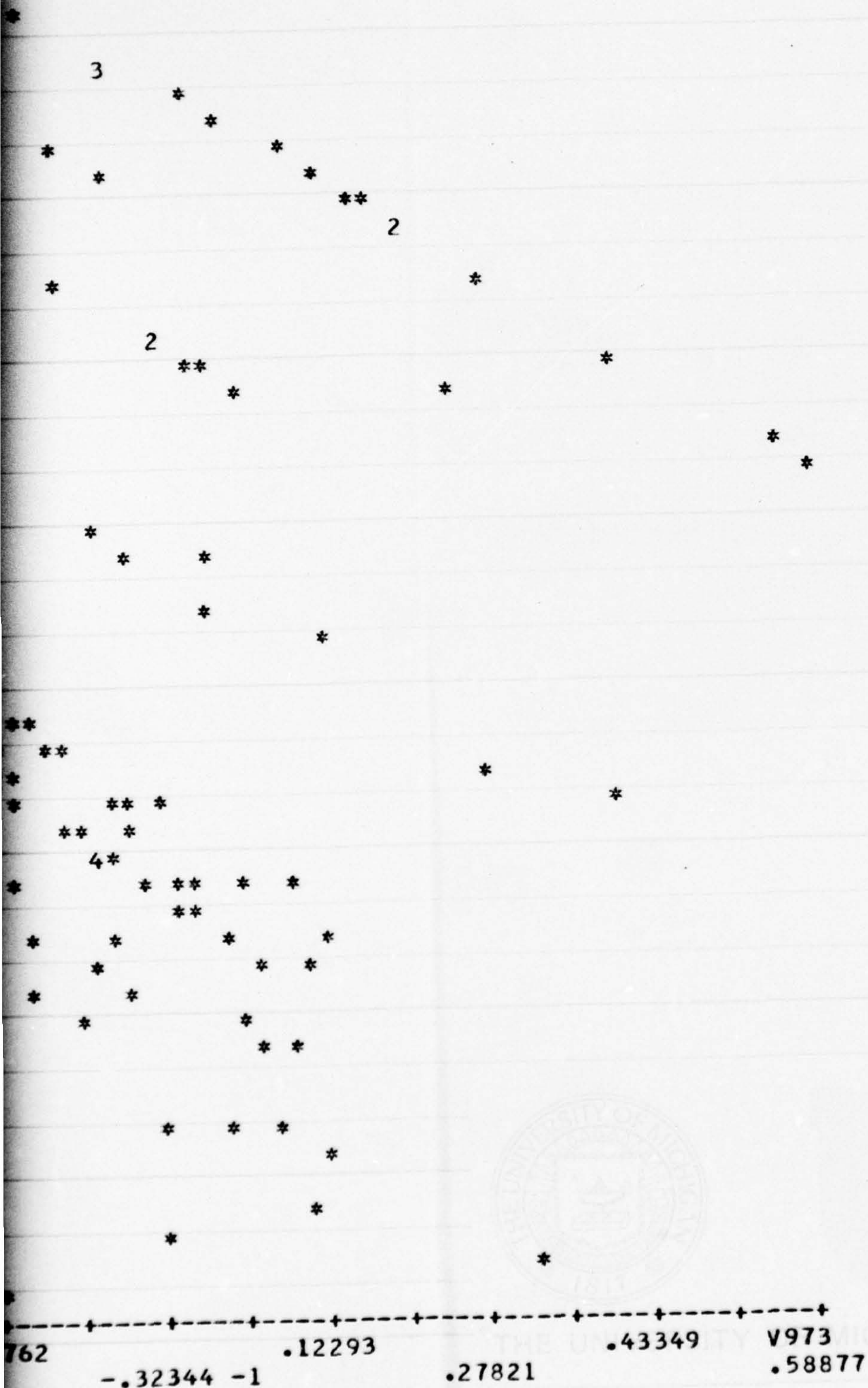

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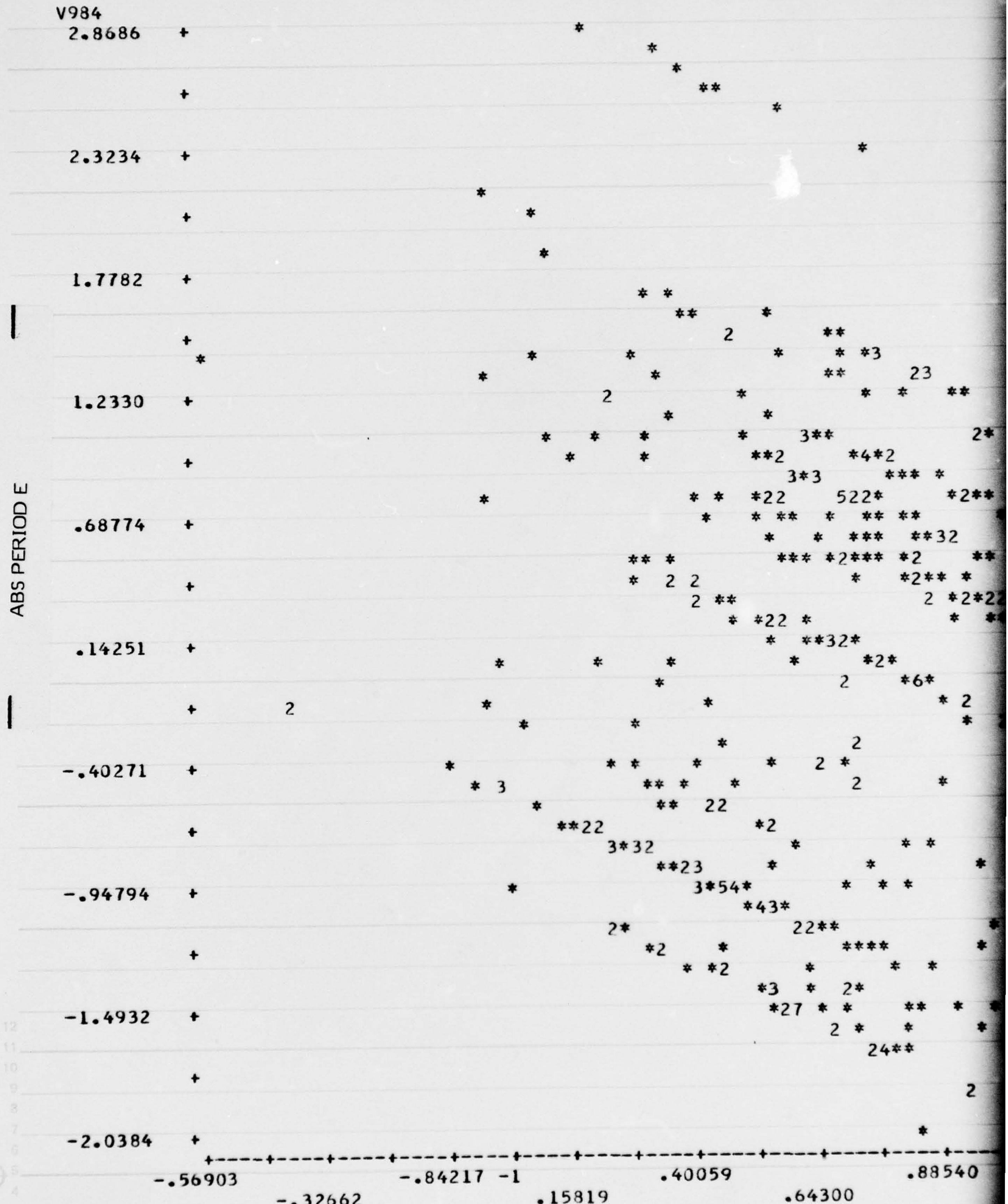

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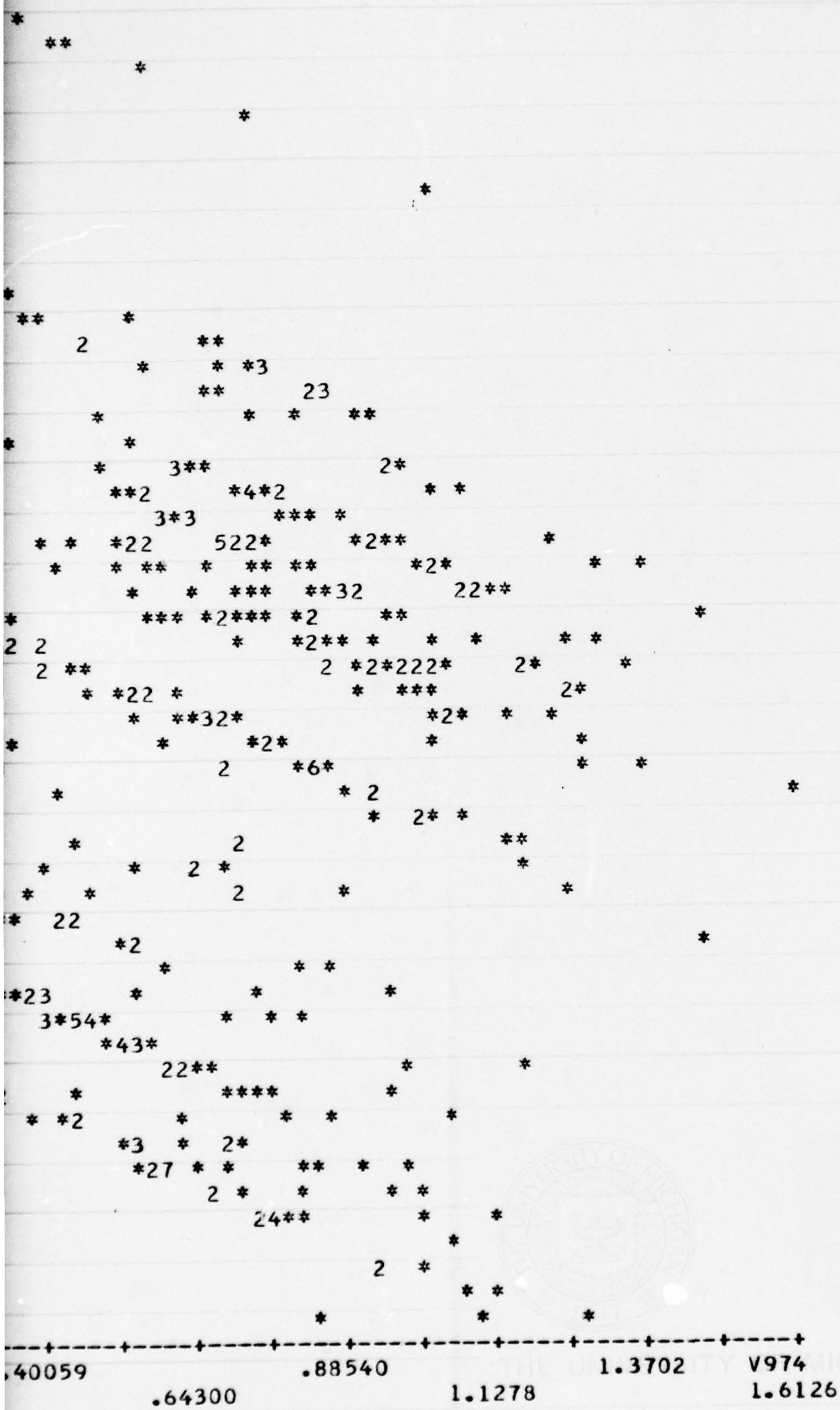

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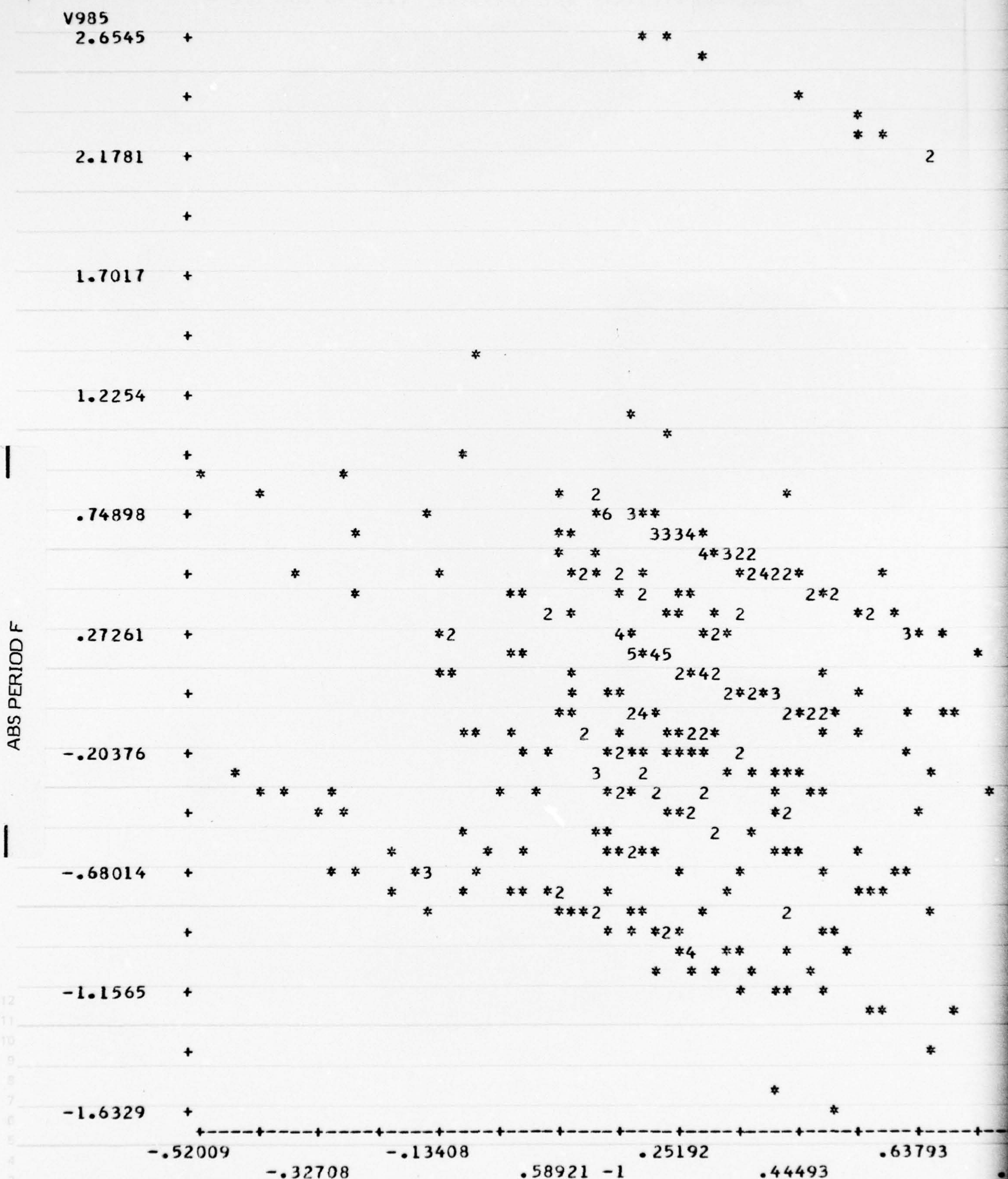

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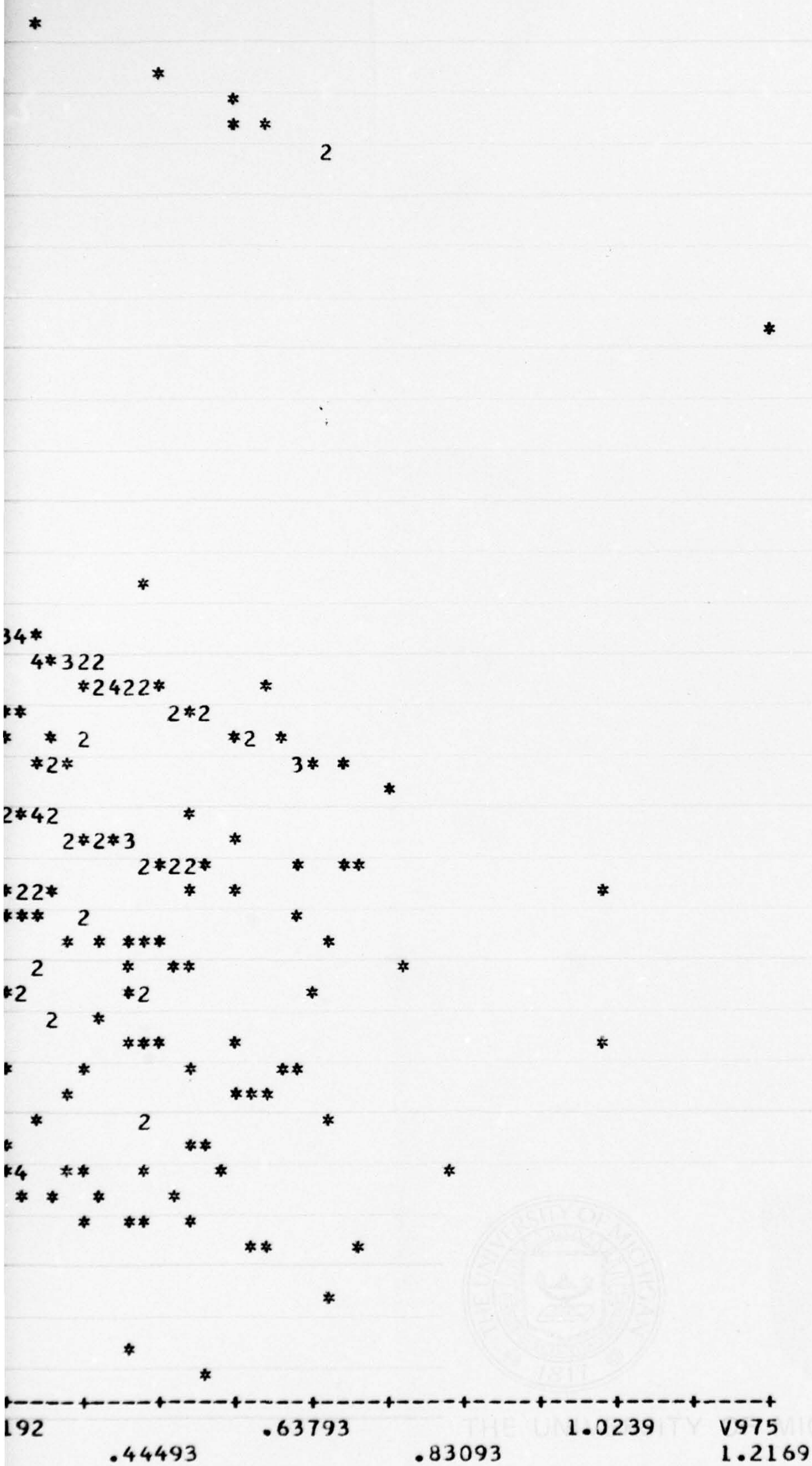

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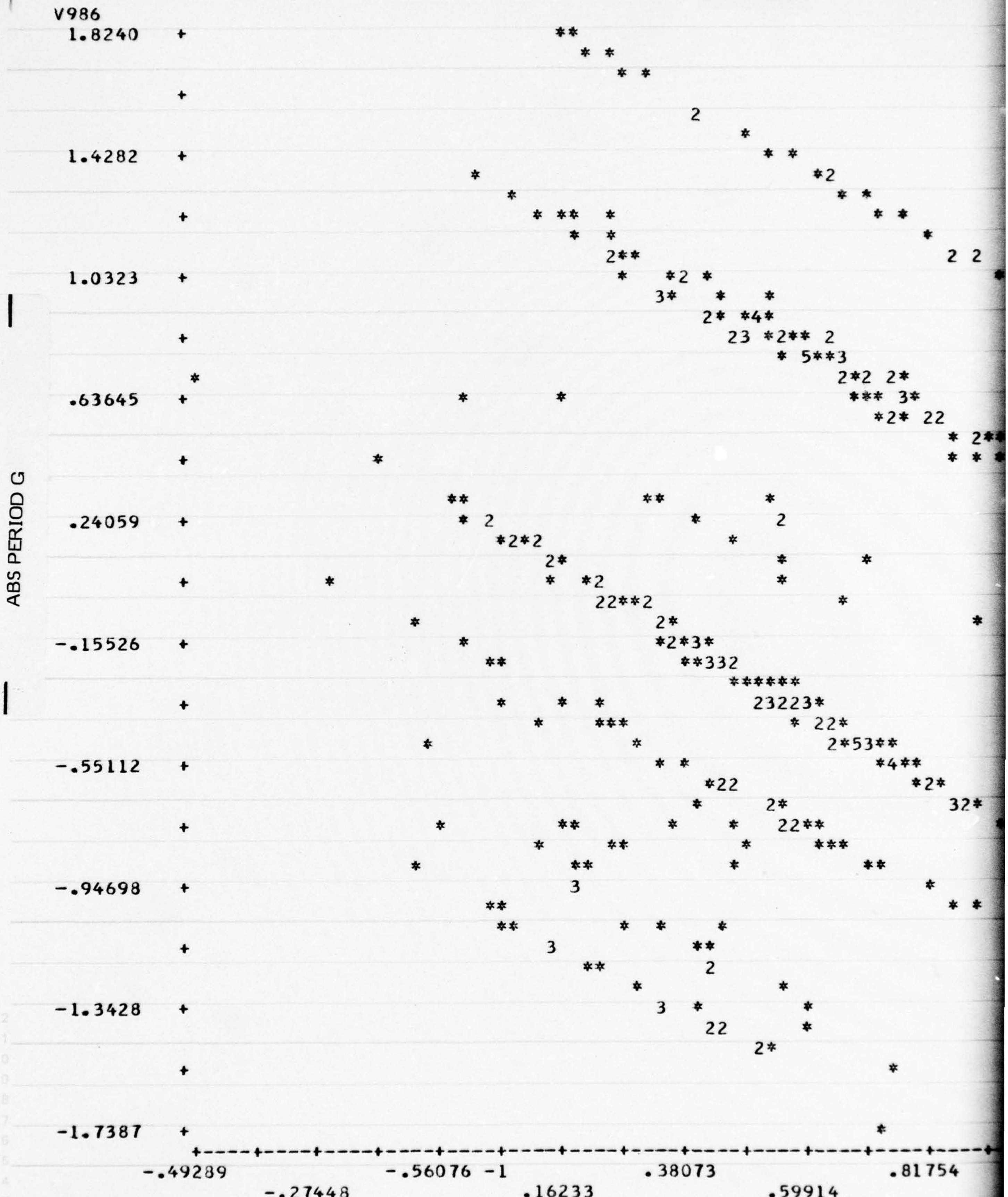

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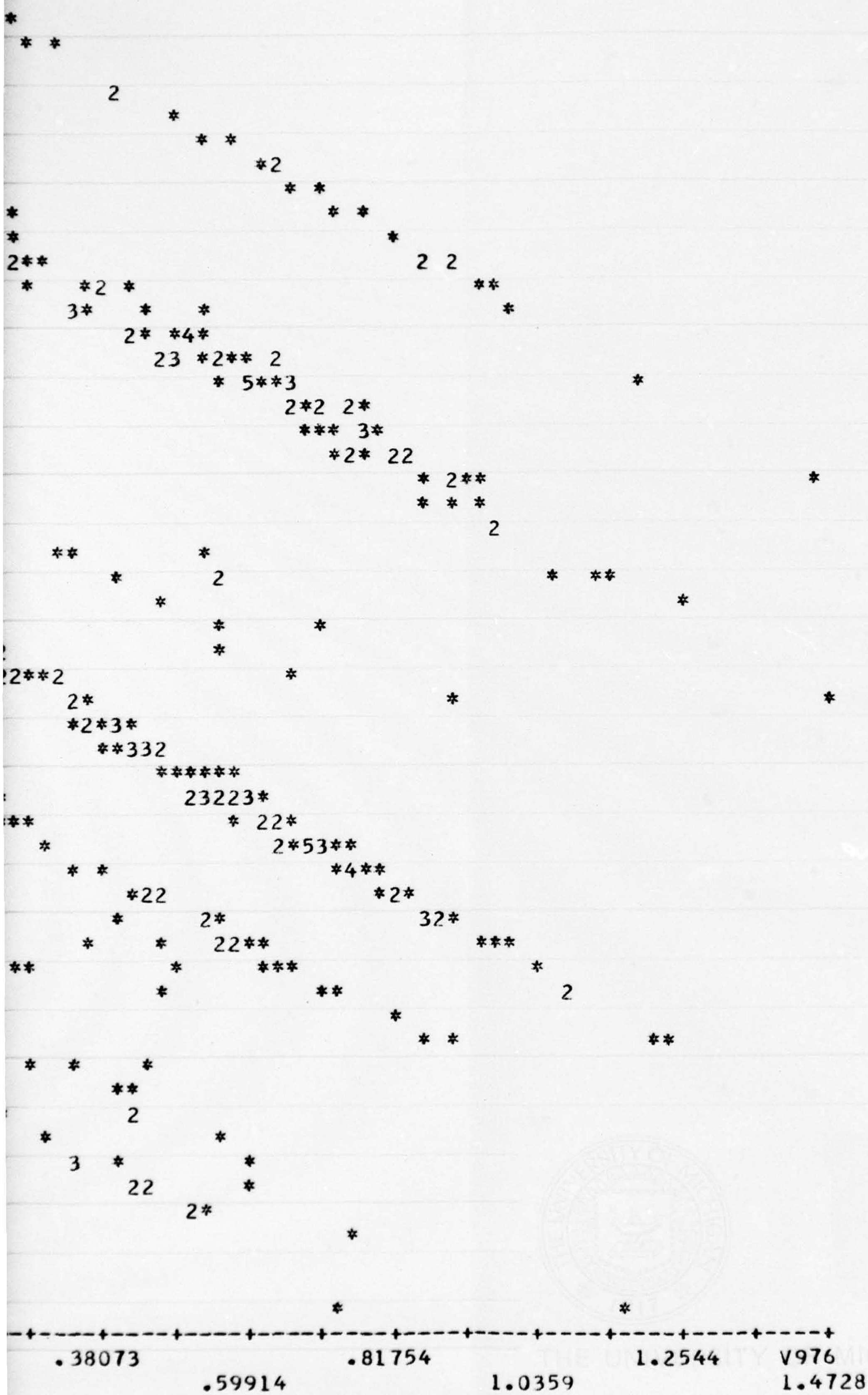

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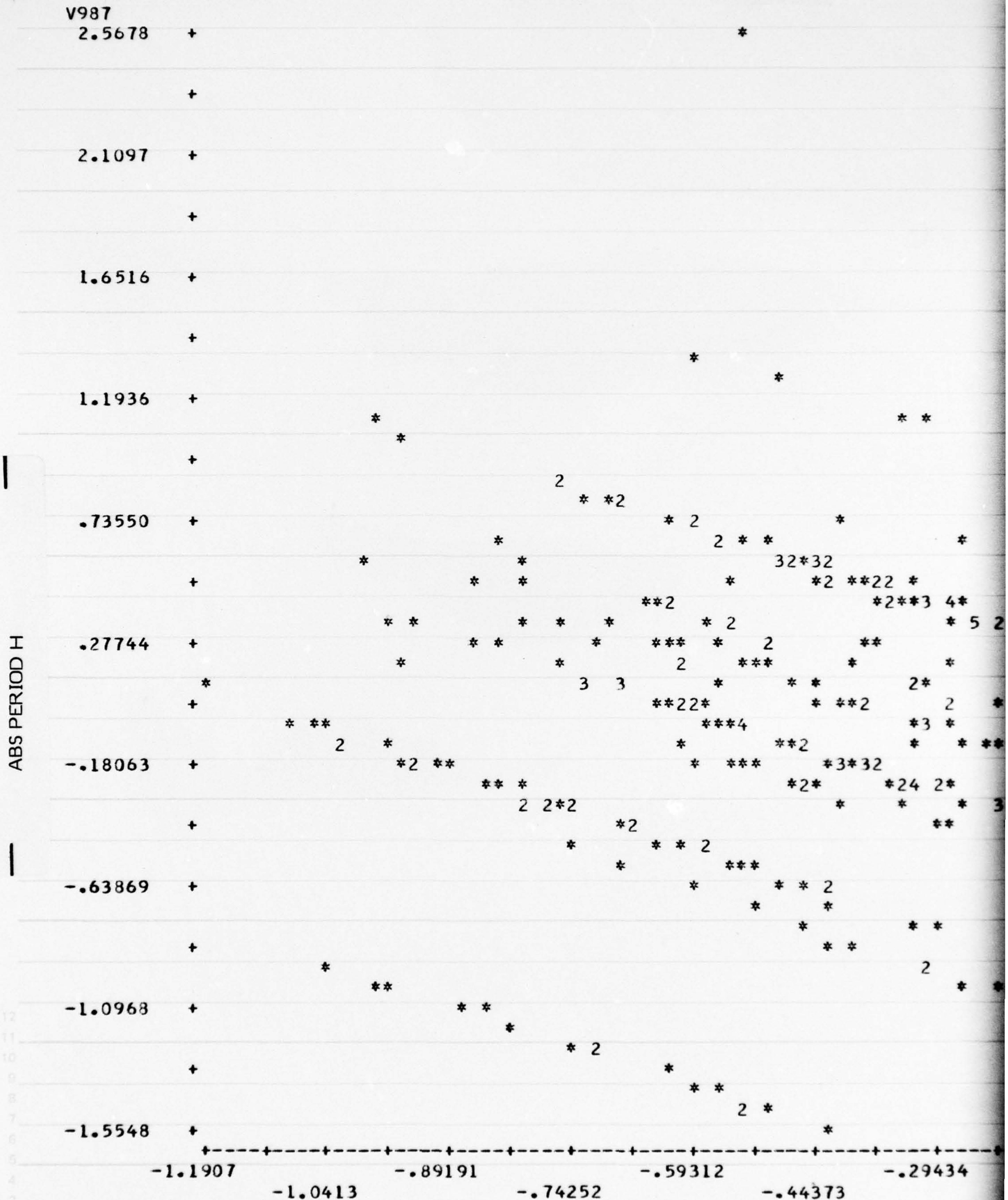

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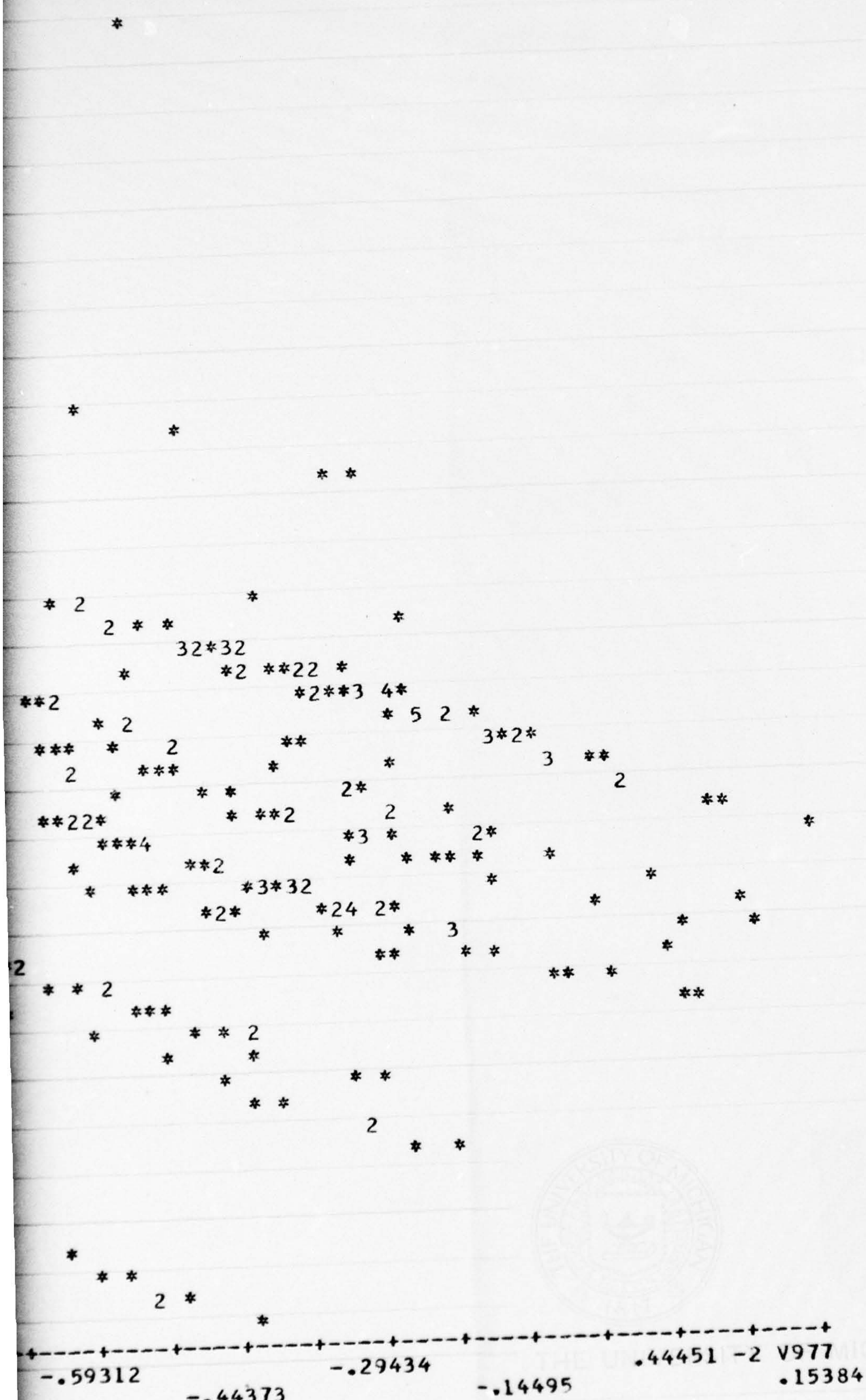

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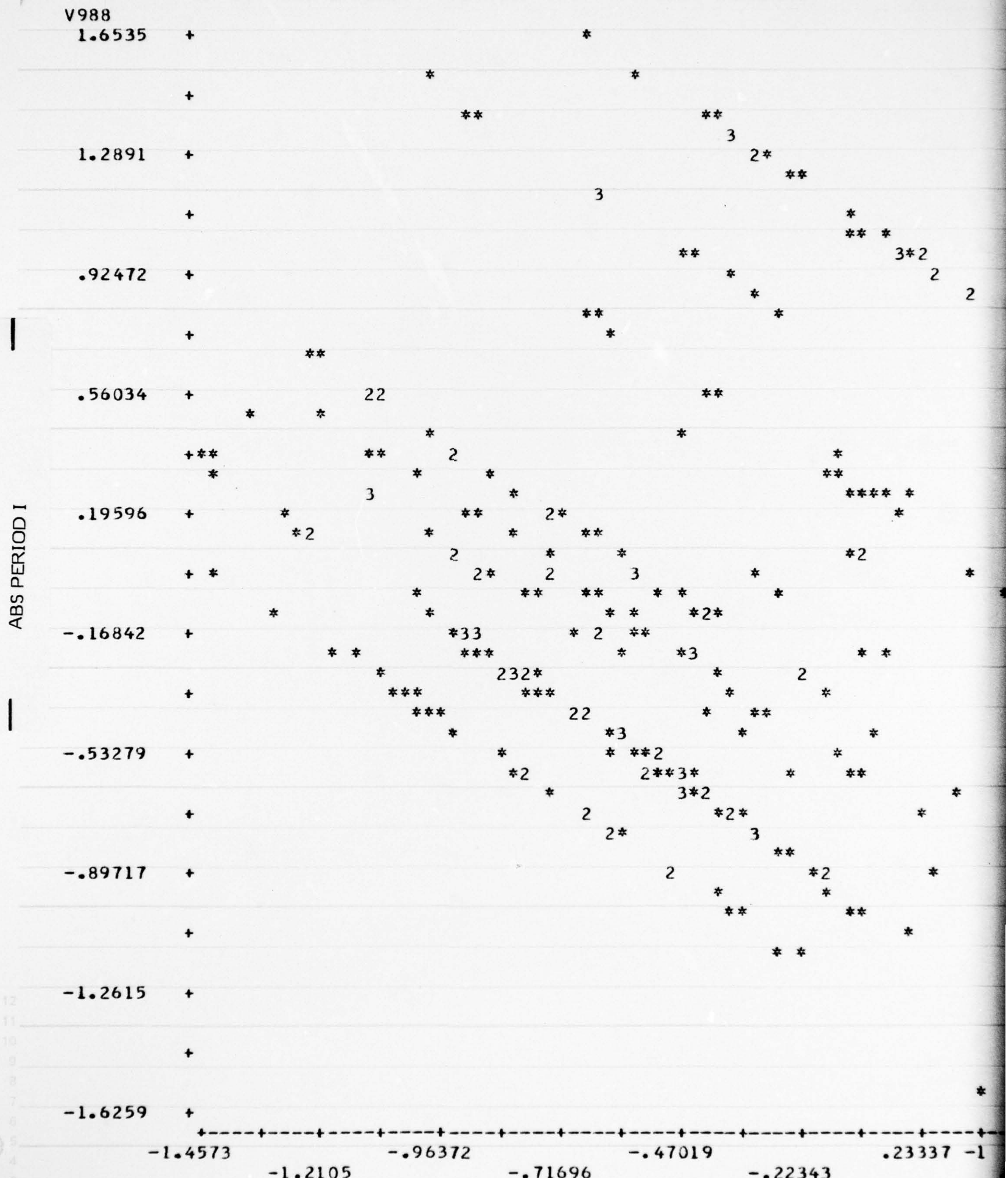

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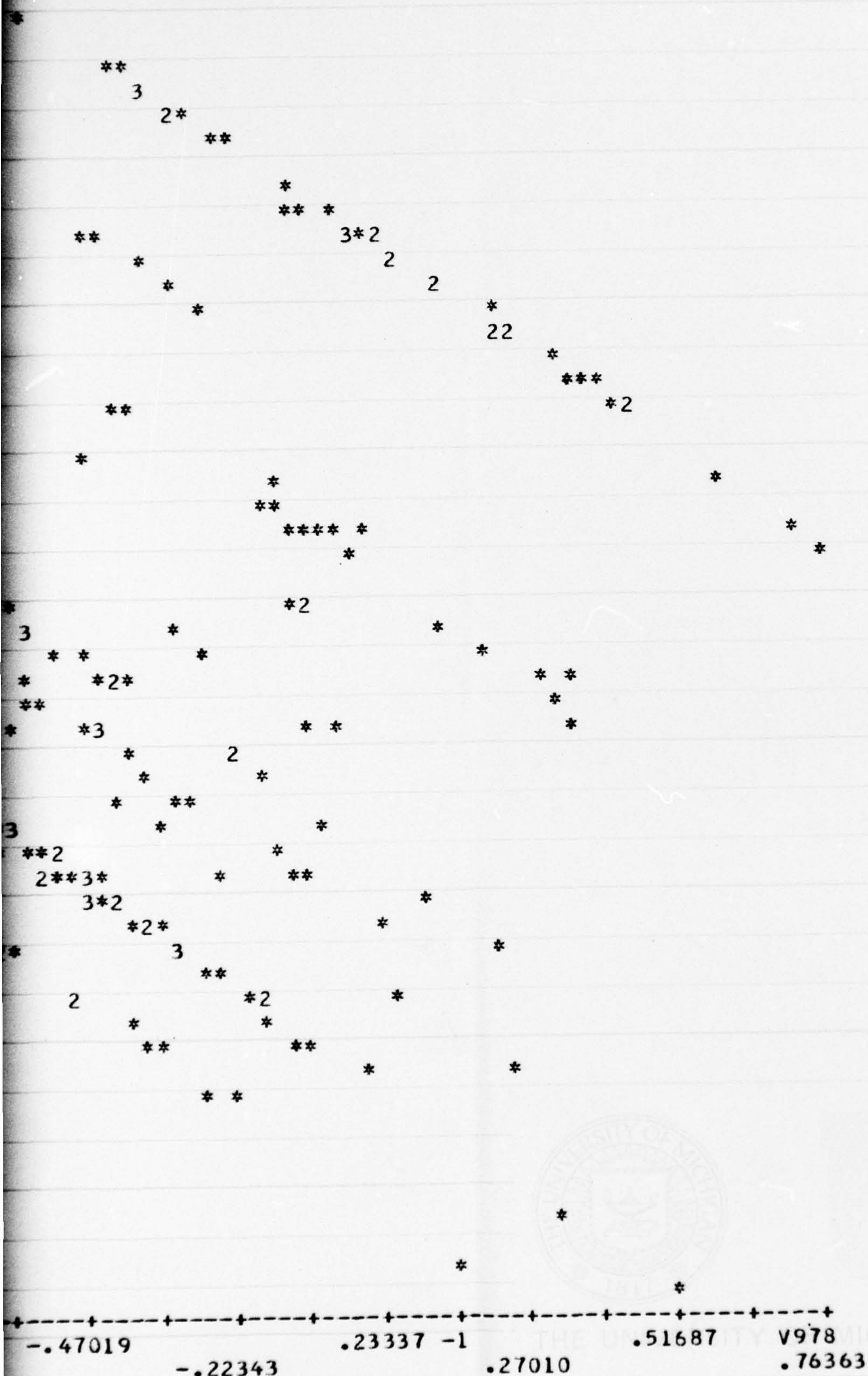

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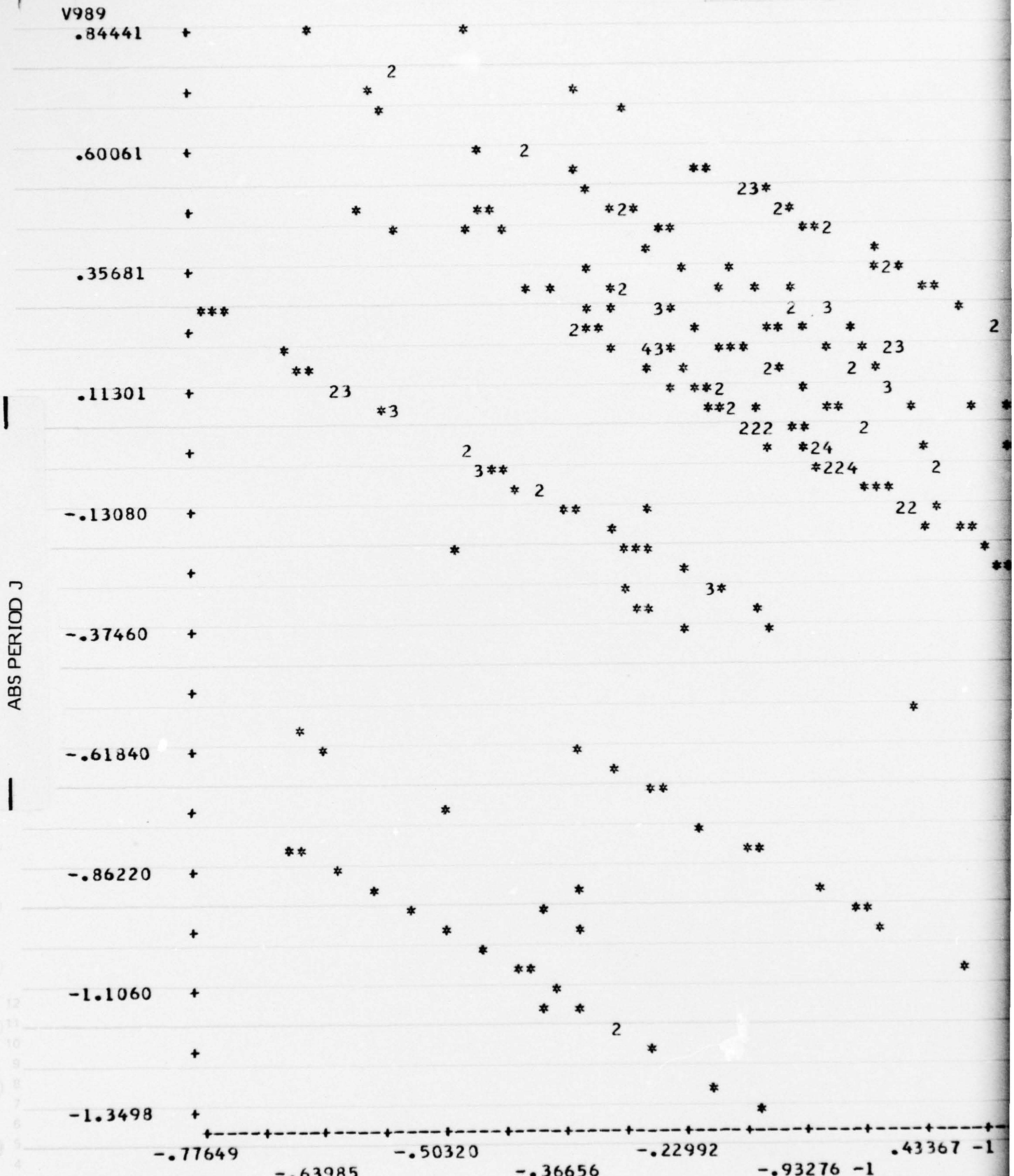

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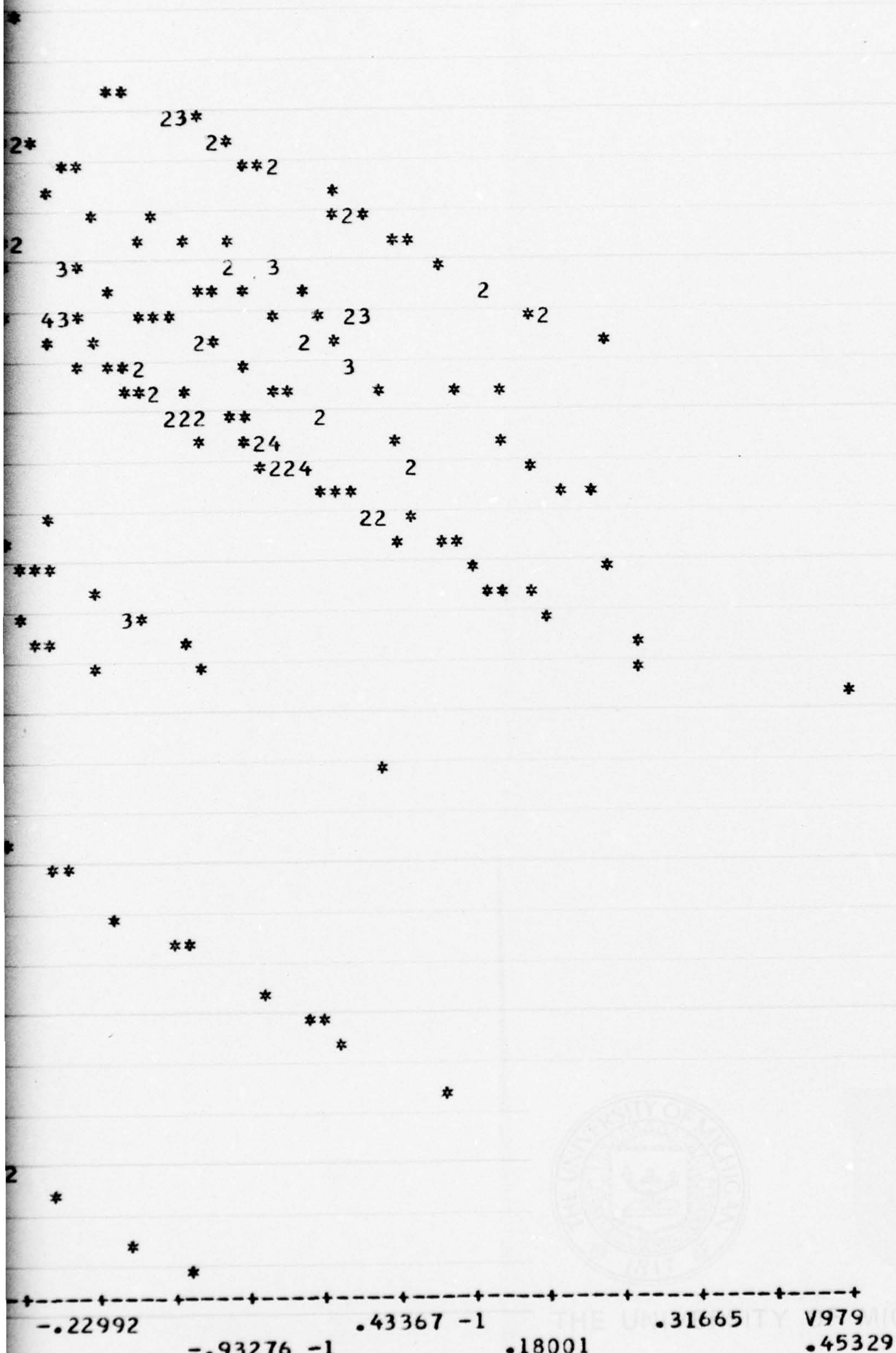

APPENDIX B

SCATTER DIAGRAMS OF RESIDUAL VALUES FOR TVE PERIODS A-I AND ABS PERIODS A-J VS. SOO INDEX SCORES

This appendix contains the regression residuals $(Y-\hat{Y})$ from each of the TVE and ABS performance periods plotted against the scores on each SOO index. Thus there are 13 plots (one for each SOO index) for each of 19 performance periods.

The codes below identify the performance period and SOO index plotted on each graph and are located at the extremes of the horizontal (SOO code) and vertical (period code) axis of the graphs.

The graphs are arranged by SOO index within each performance period. Thus the graphs of the TVE period A residuals vs. each of the 13 SOO indices appear together and precede the graphs for the TVE period B residuals, etc. The order of periods and indices within periods is as given in the codes.

CODES

RESIDUALS FROM:	
TVEA	V941
TVEB	V942
TVEC	V943
TVED	V944
TVEE	V945
TVEF	V946
TVEG	V947
TVEH	V948
TVEI	V949
ABSA	980
ABSB	981
ABSC	982
ABSD	983
ABSE	984
ABSF	985
ABSG	986
ABSH	987
ABSI	988
ABSJ	989

SOO INDEX:		
Supervisory Support	176	SUP
Supervisory Goal Emphasis	178	SUP
Supervisory Work Facilitation	180	SUP
Supervisory Team Building	182	SUP
Peer Support	184	PEER
Peer Goal Emphasis	186	PEER
Peer Work Facilitation	188	PEER
Peer Interaction Facilitation	190	PEER
Human Resources Primacy	196	HUM
Communication Flow	197	COMM
Motivational Conditions	198	MOTI
Decision Making Practices	199	DEC
Satisfaction	200	SATI

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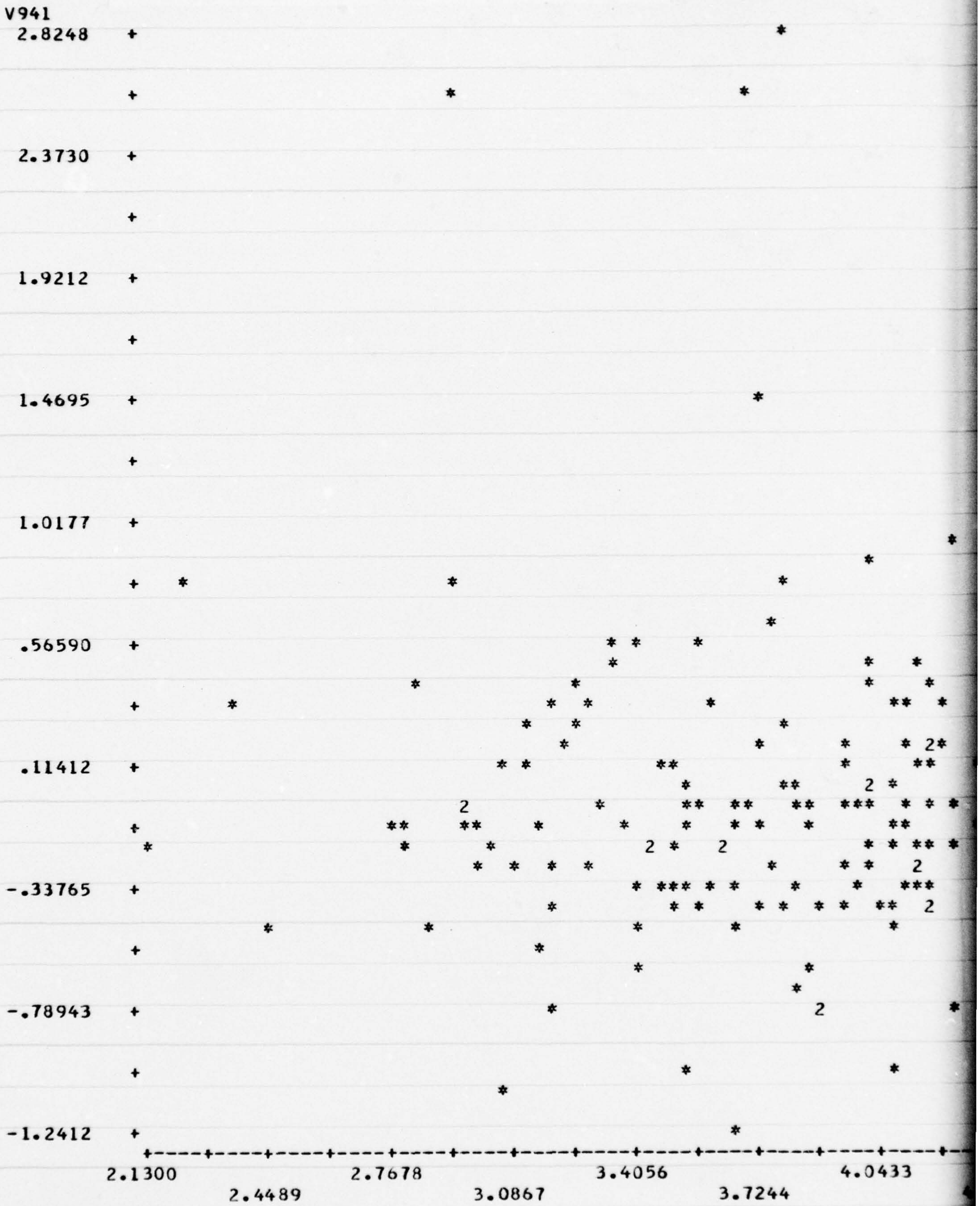

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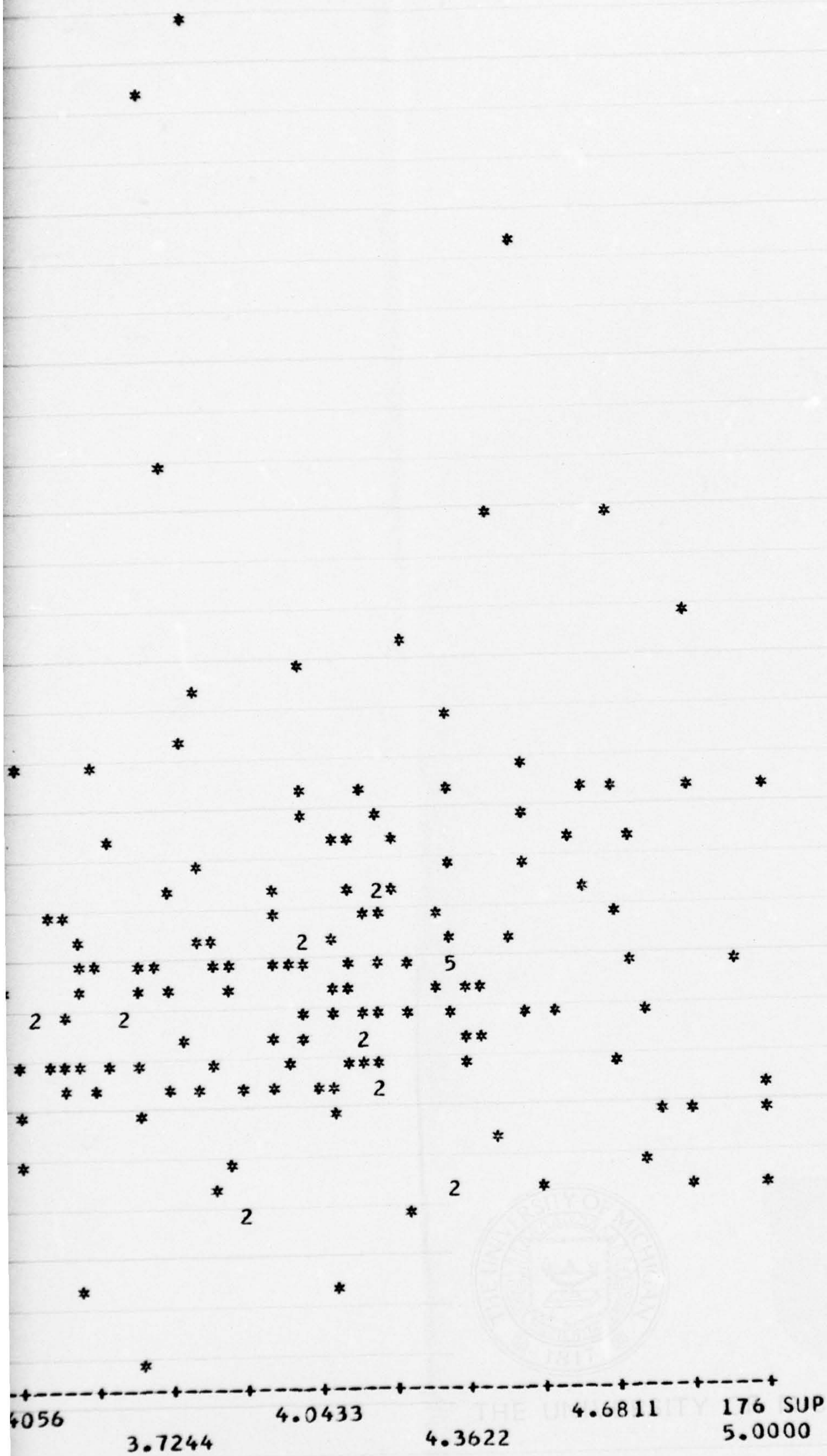

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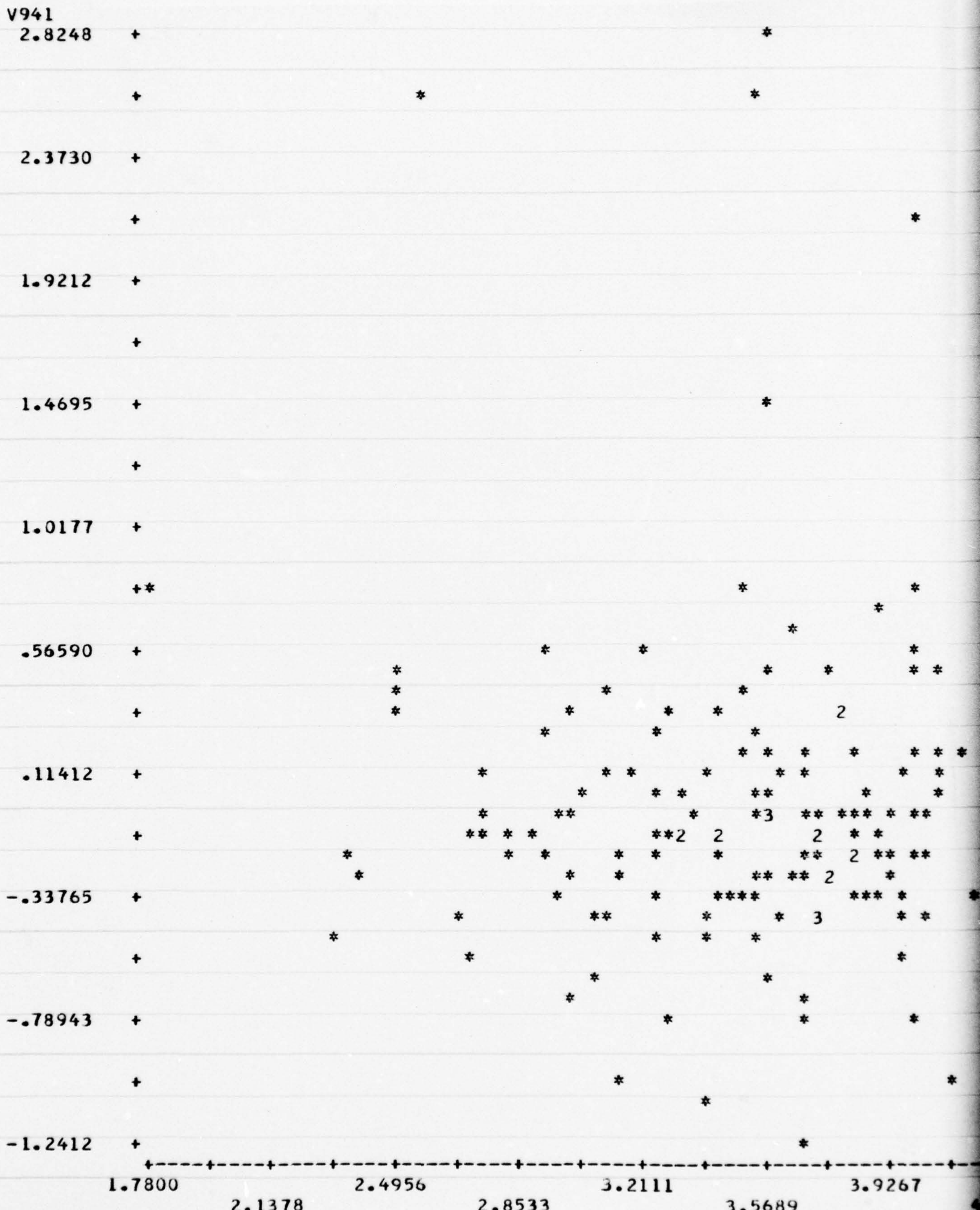

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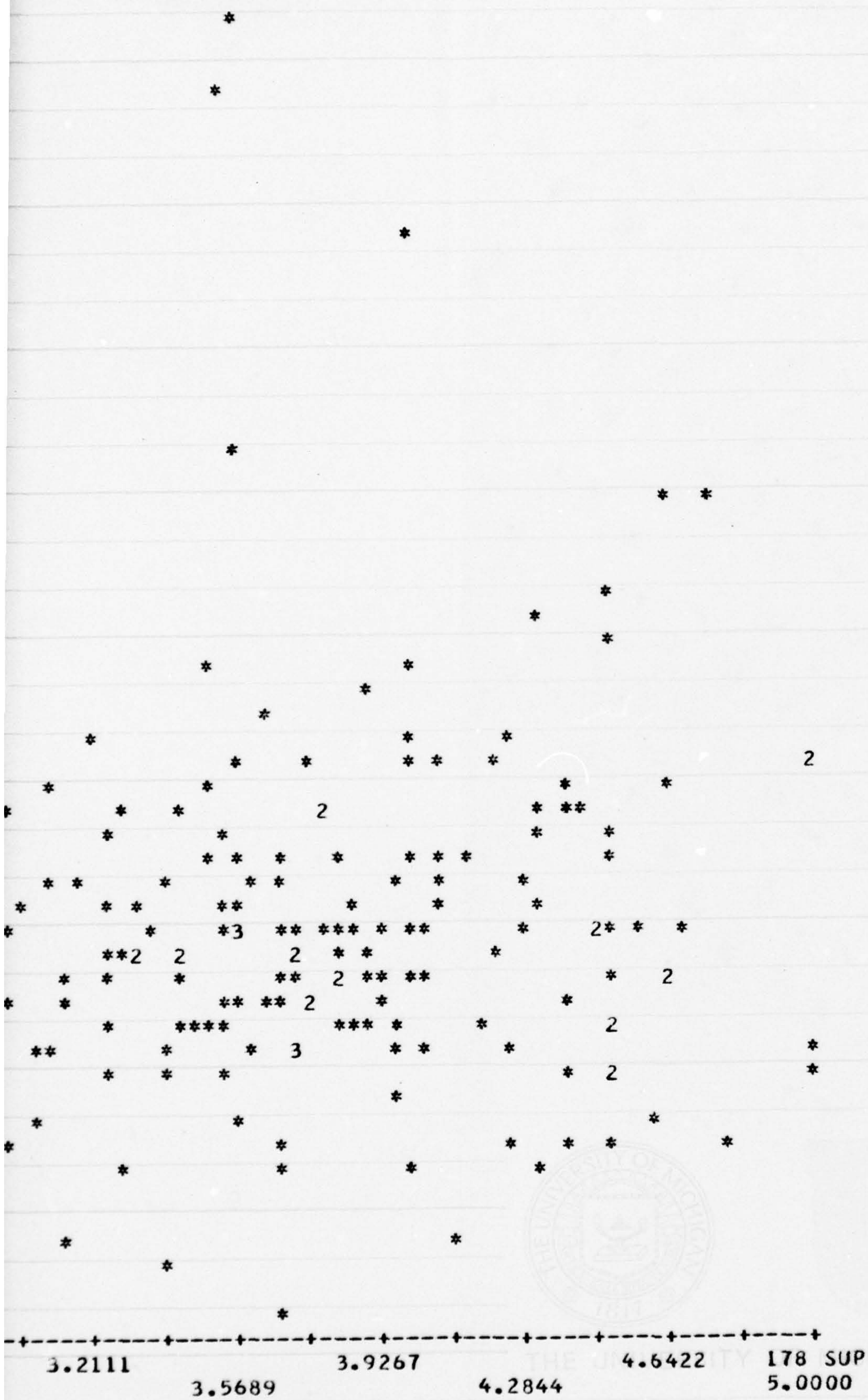

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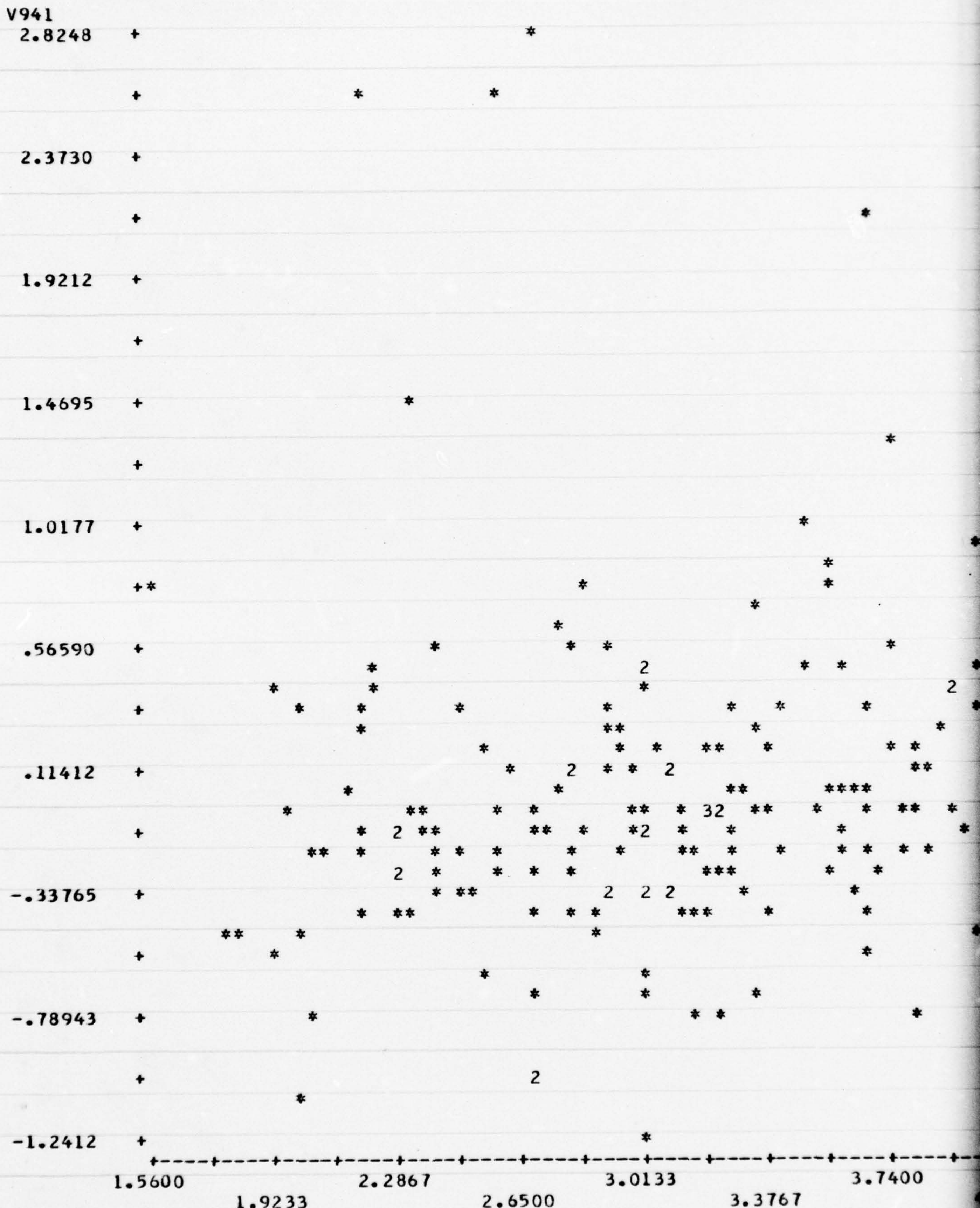

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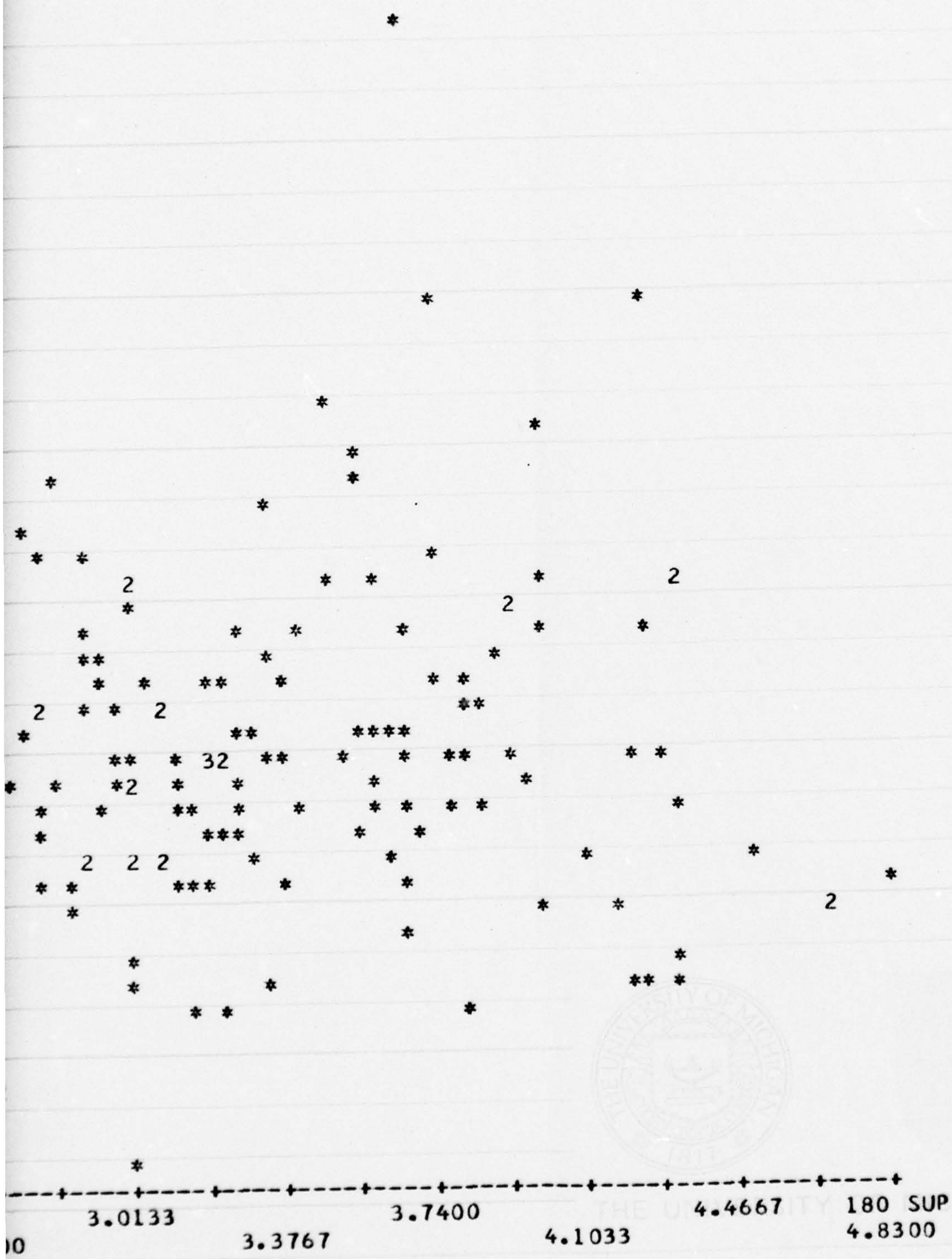

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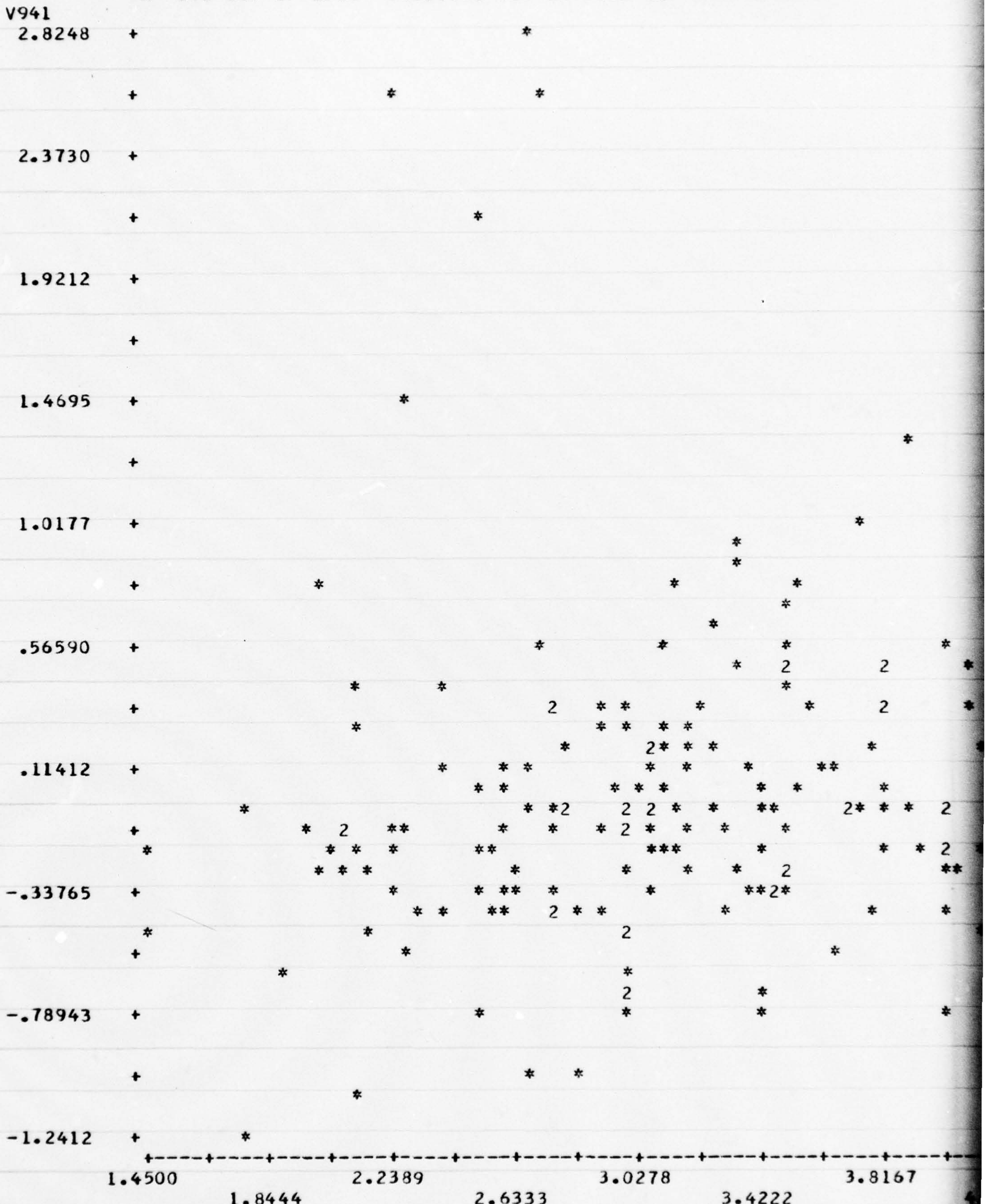

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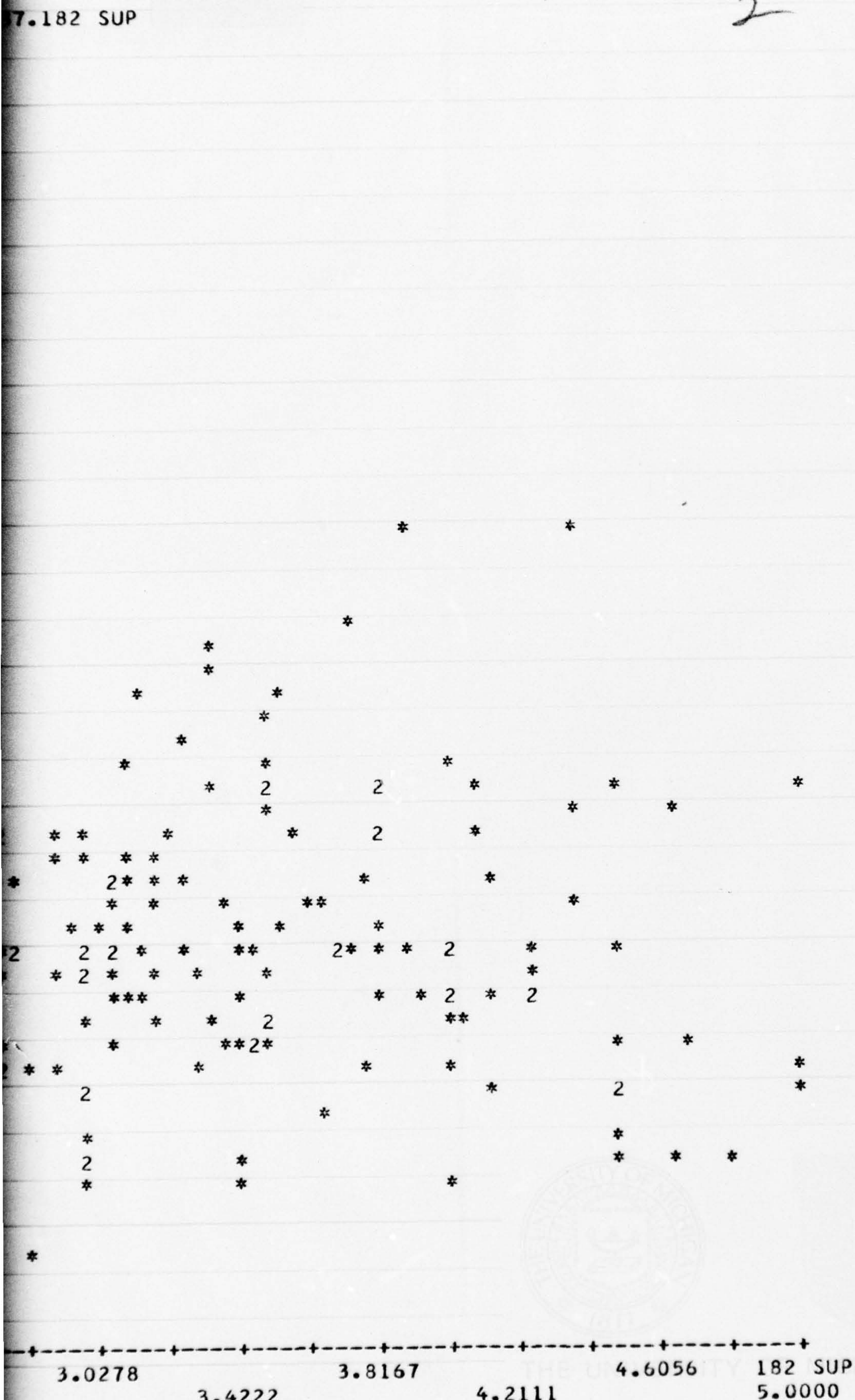

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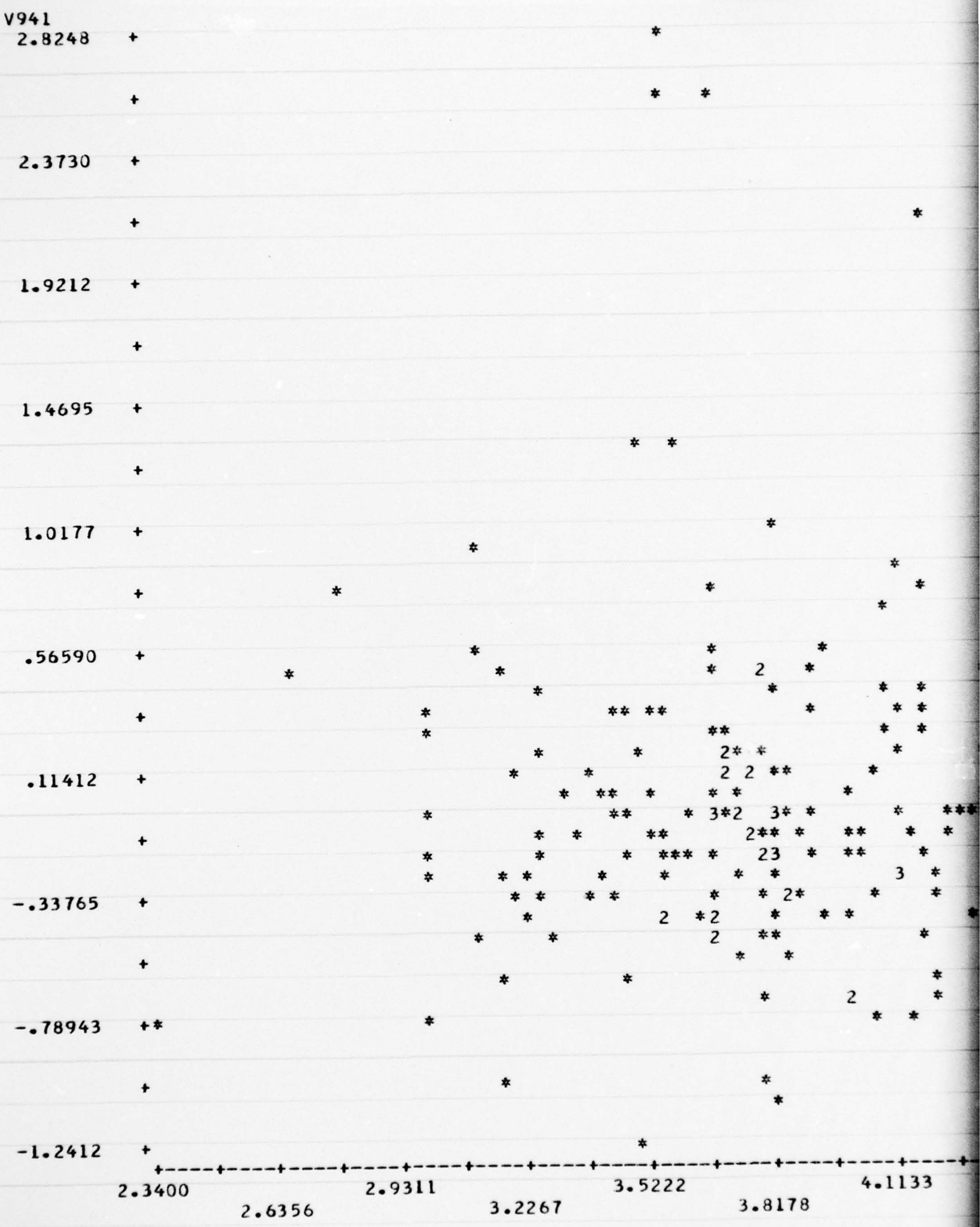

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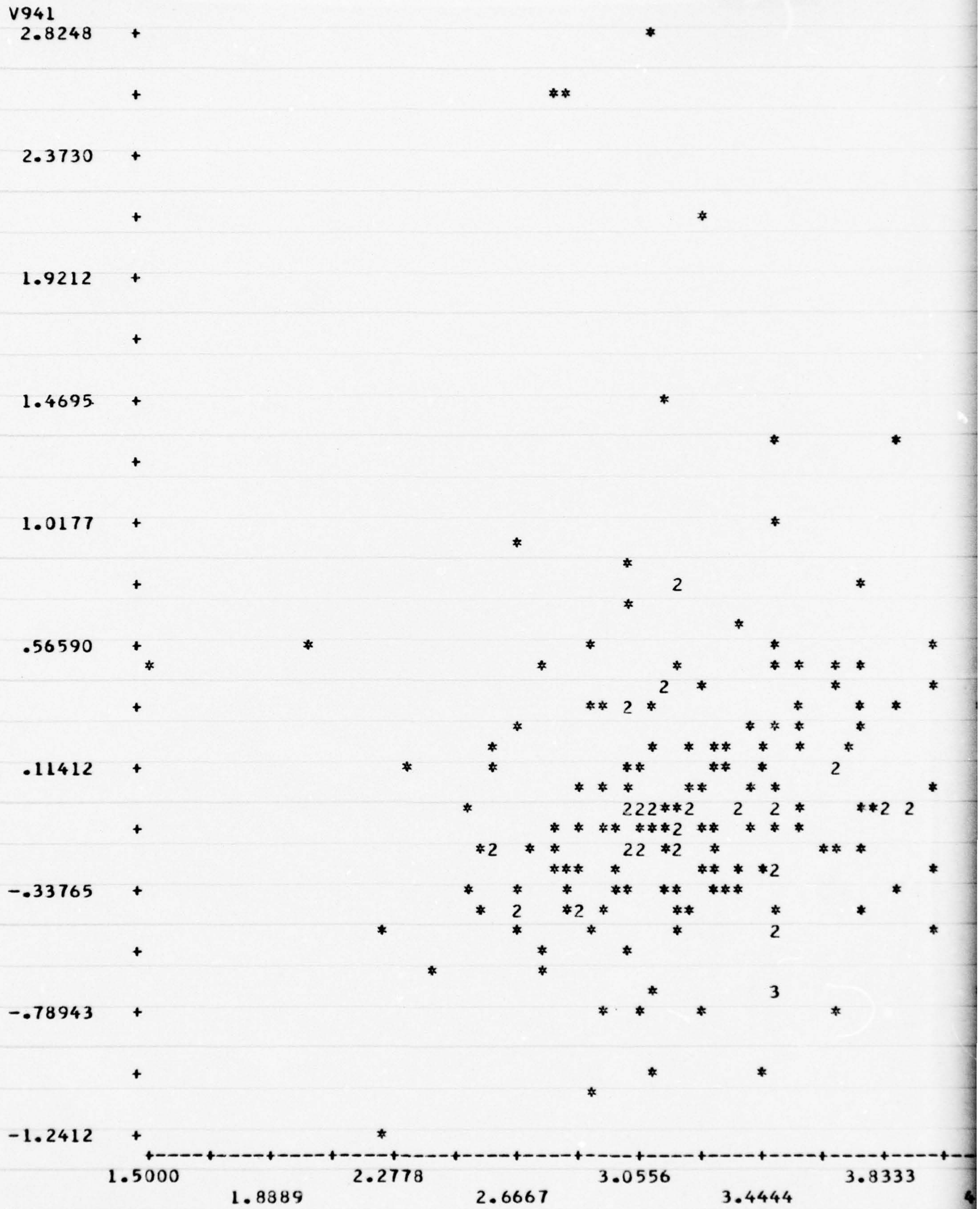

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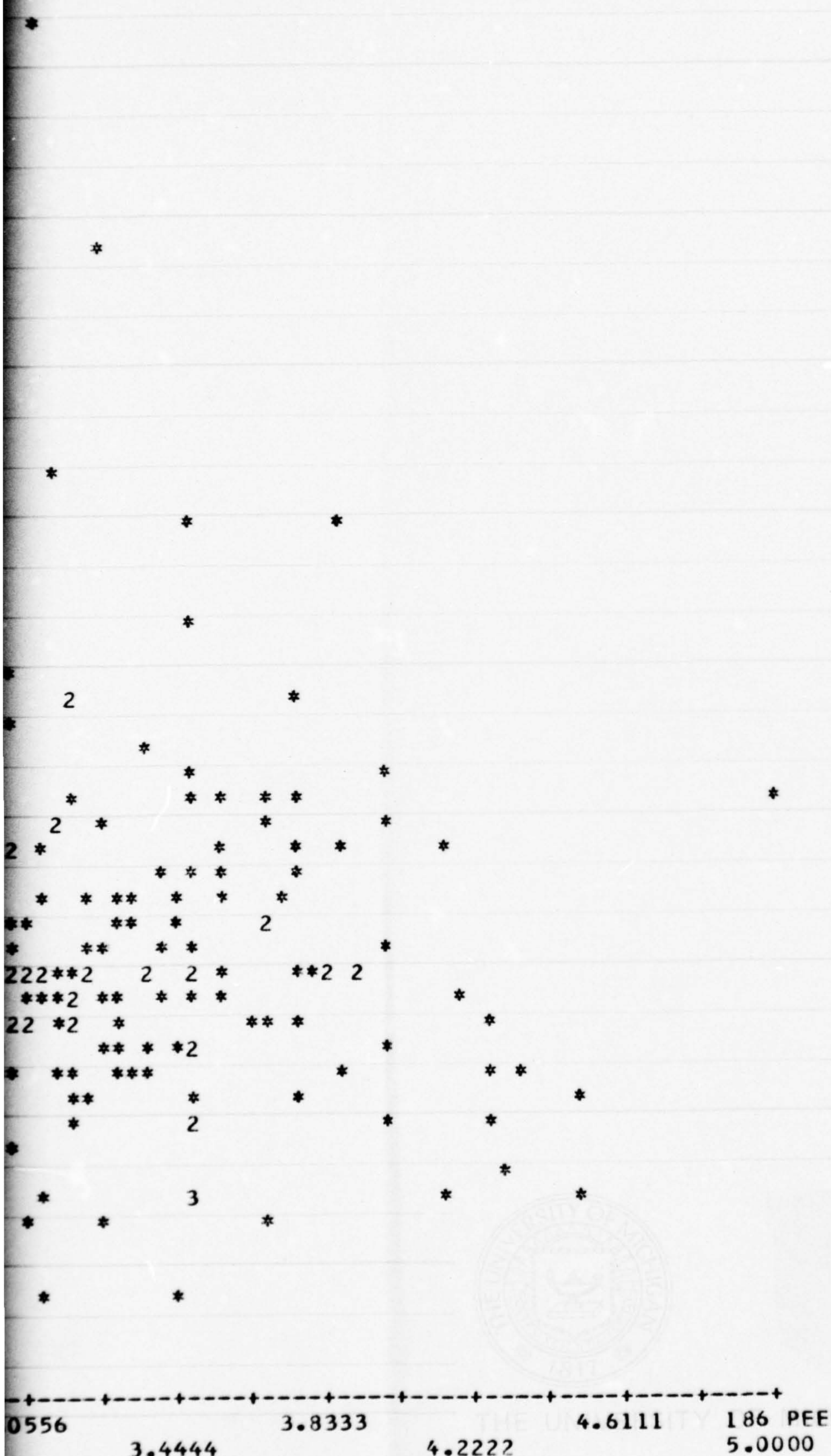

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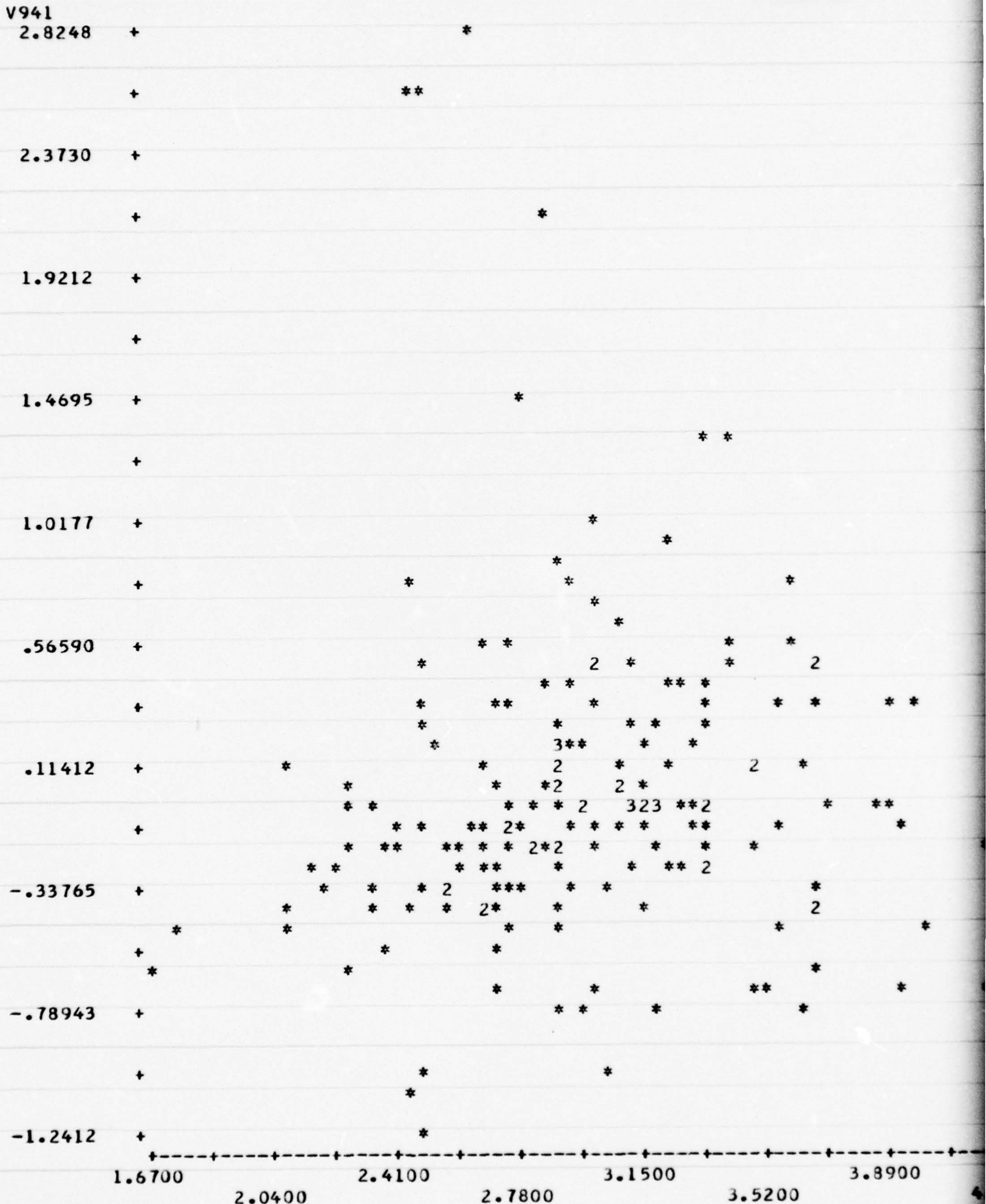

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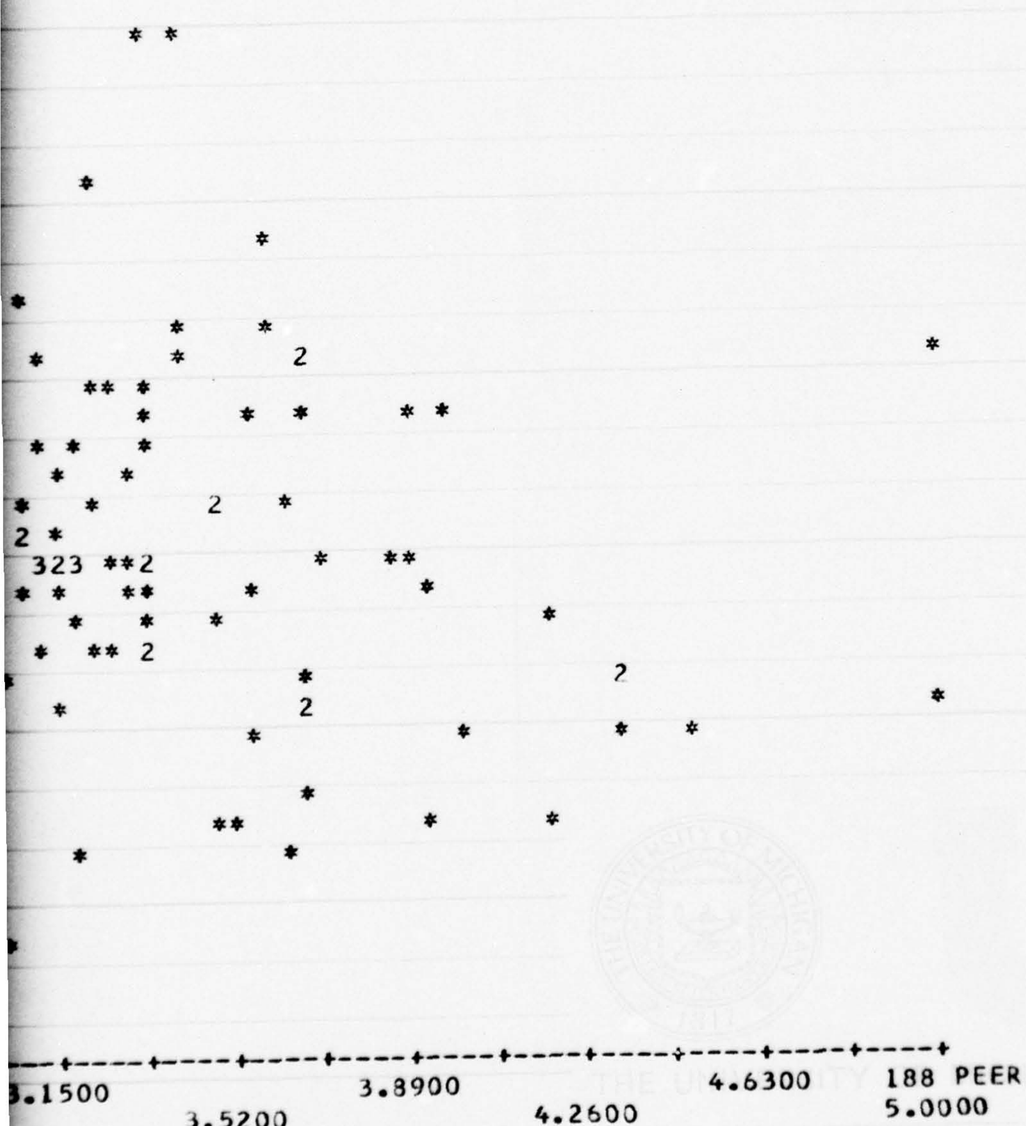

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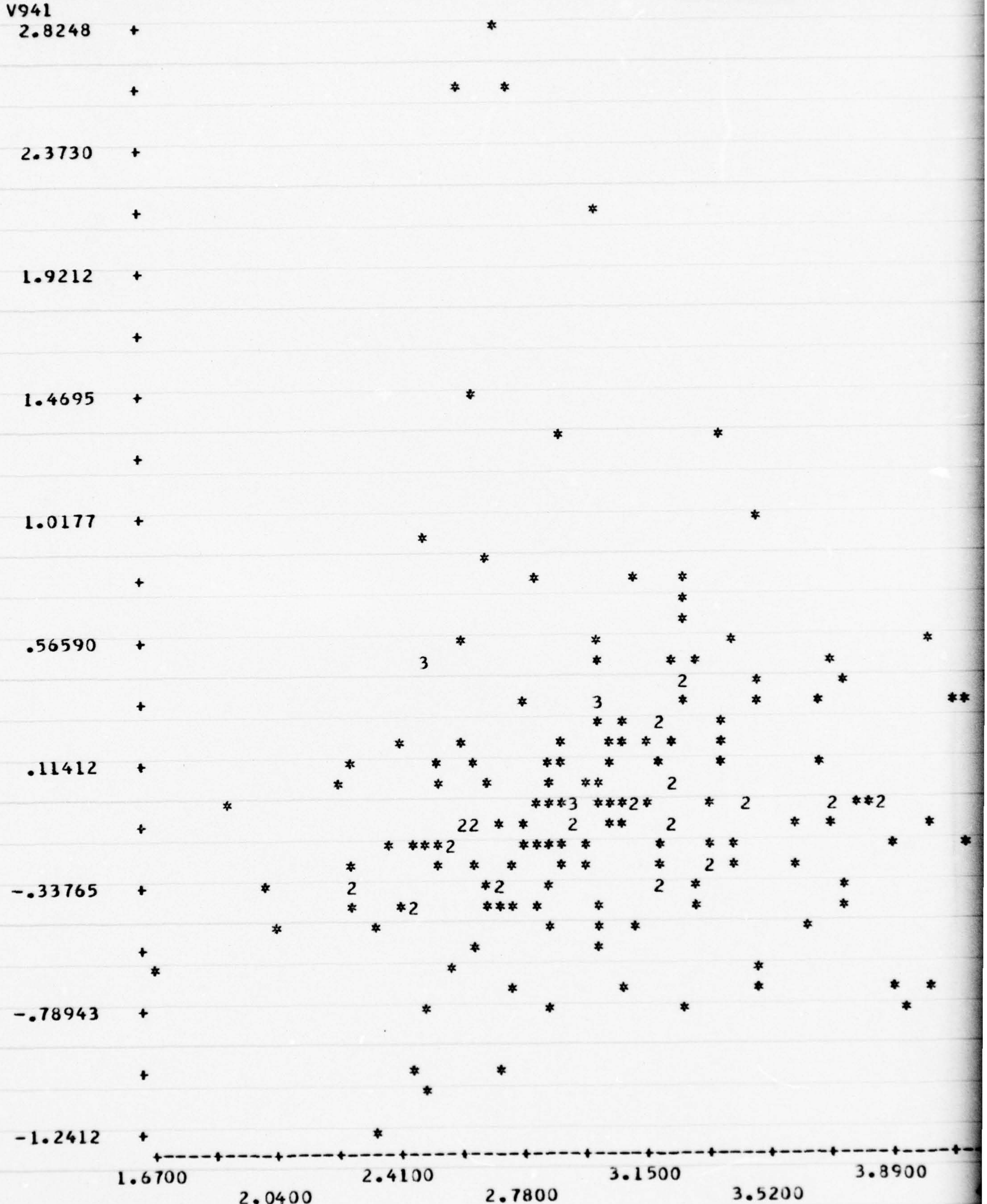

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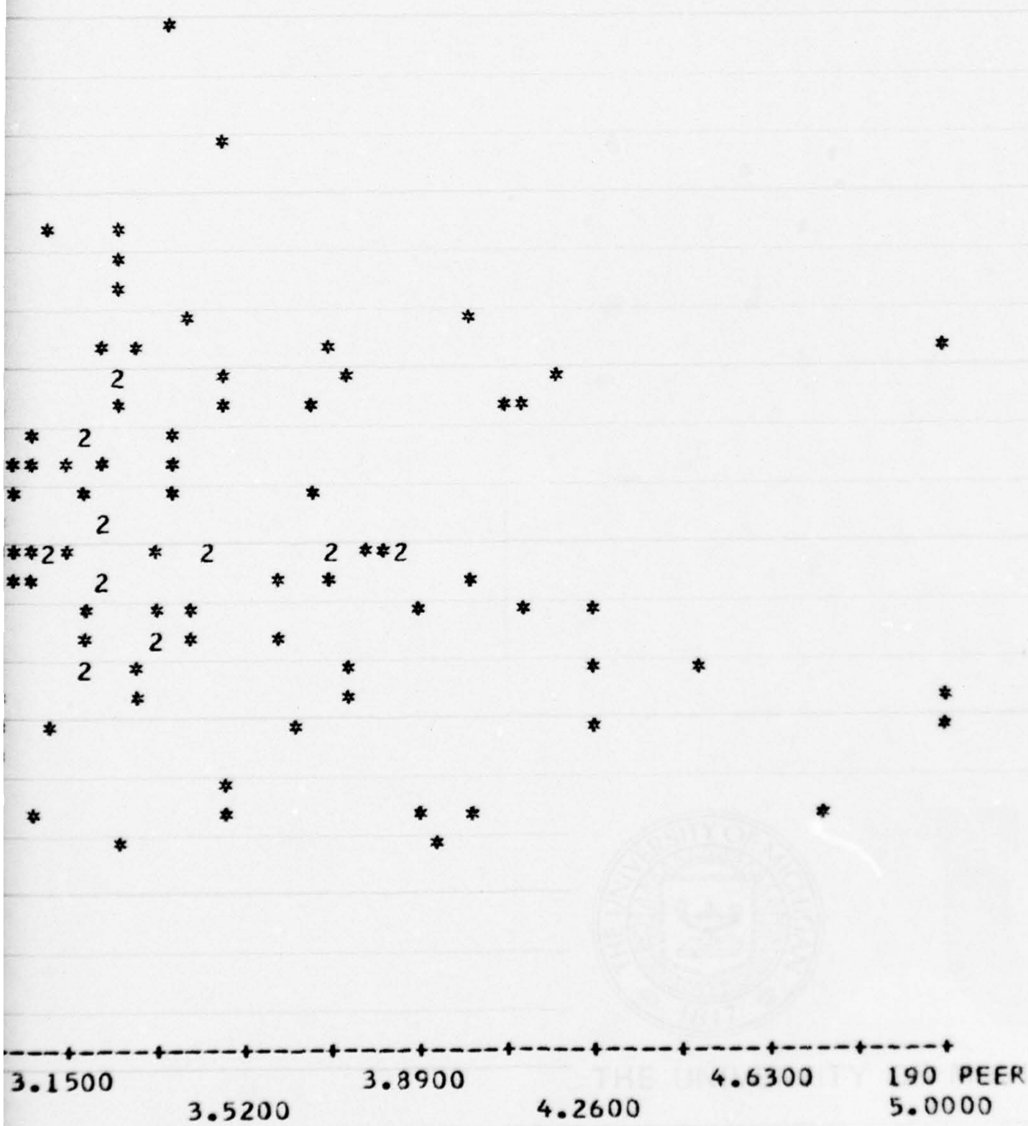

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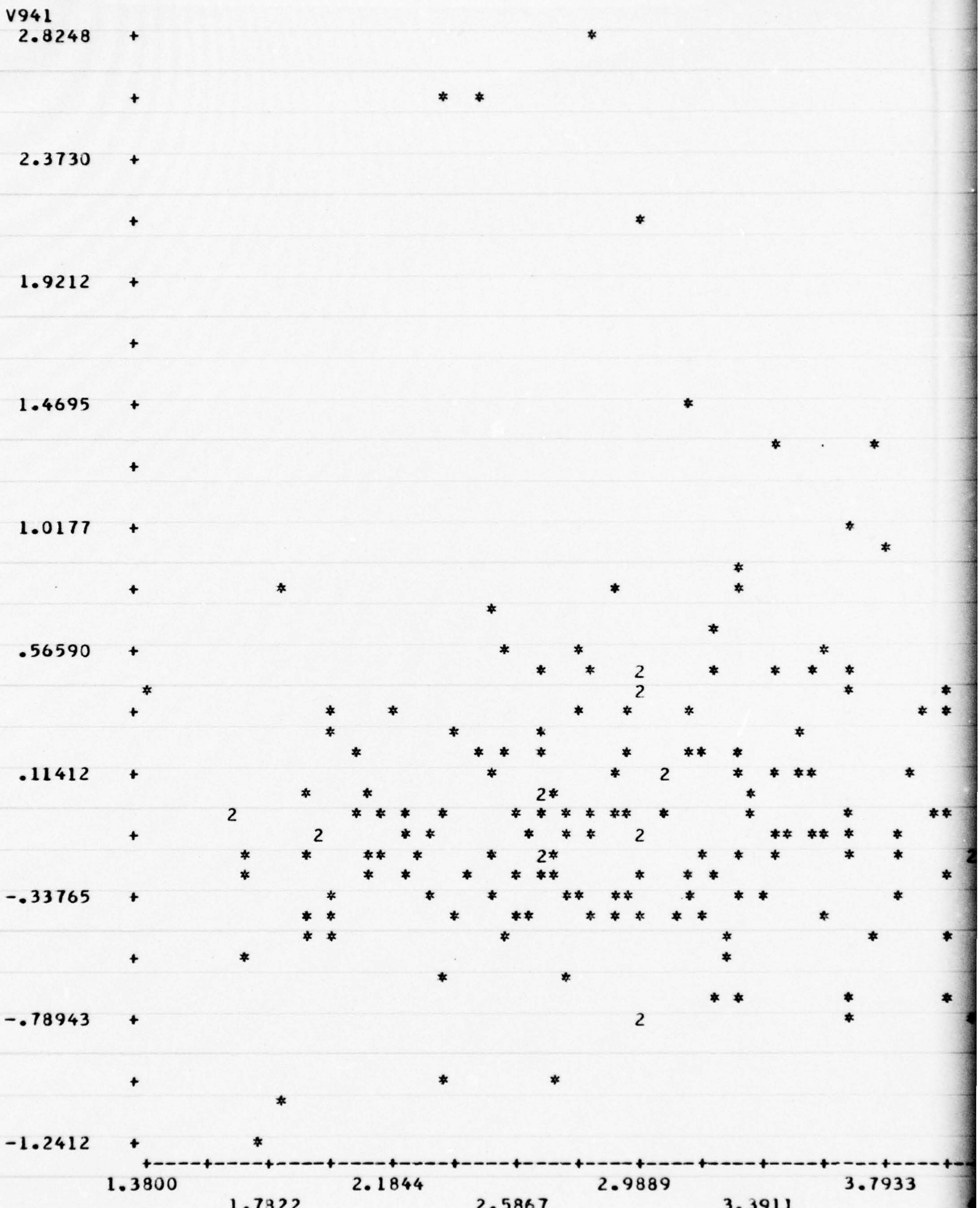

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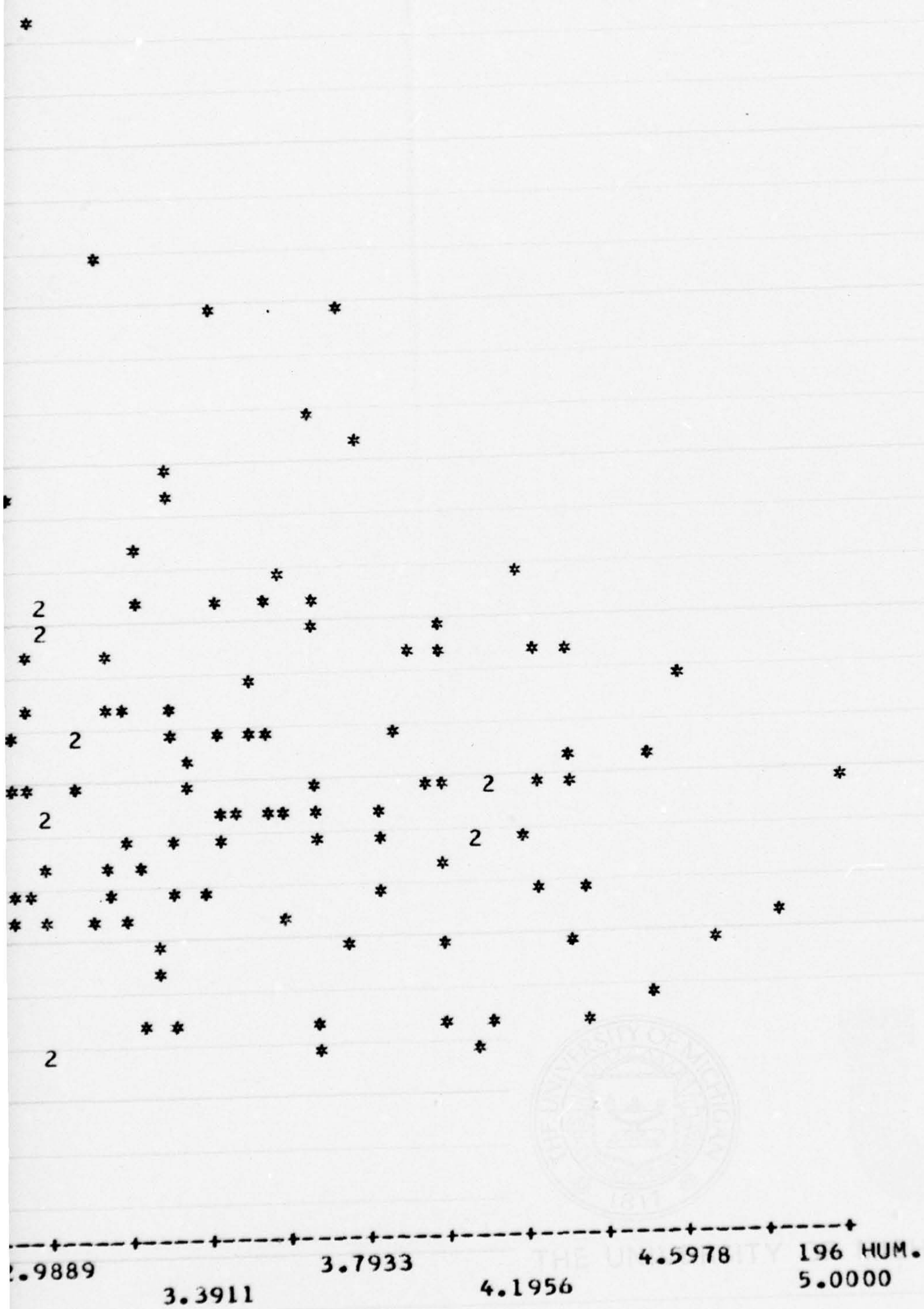

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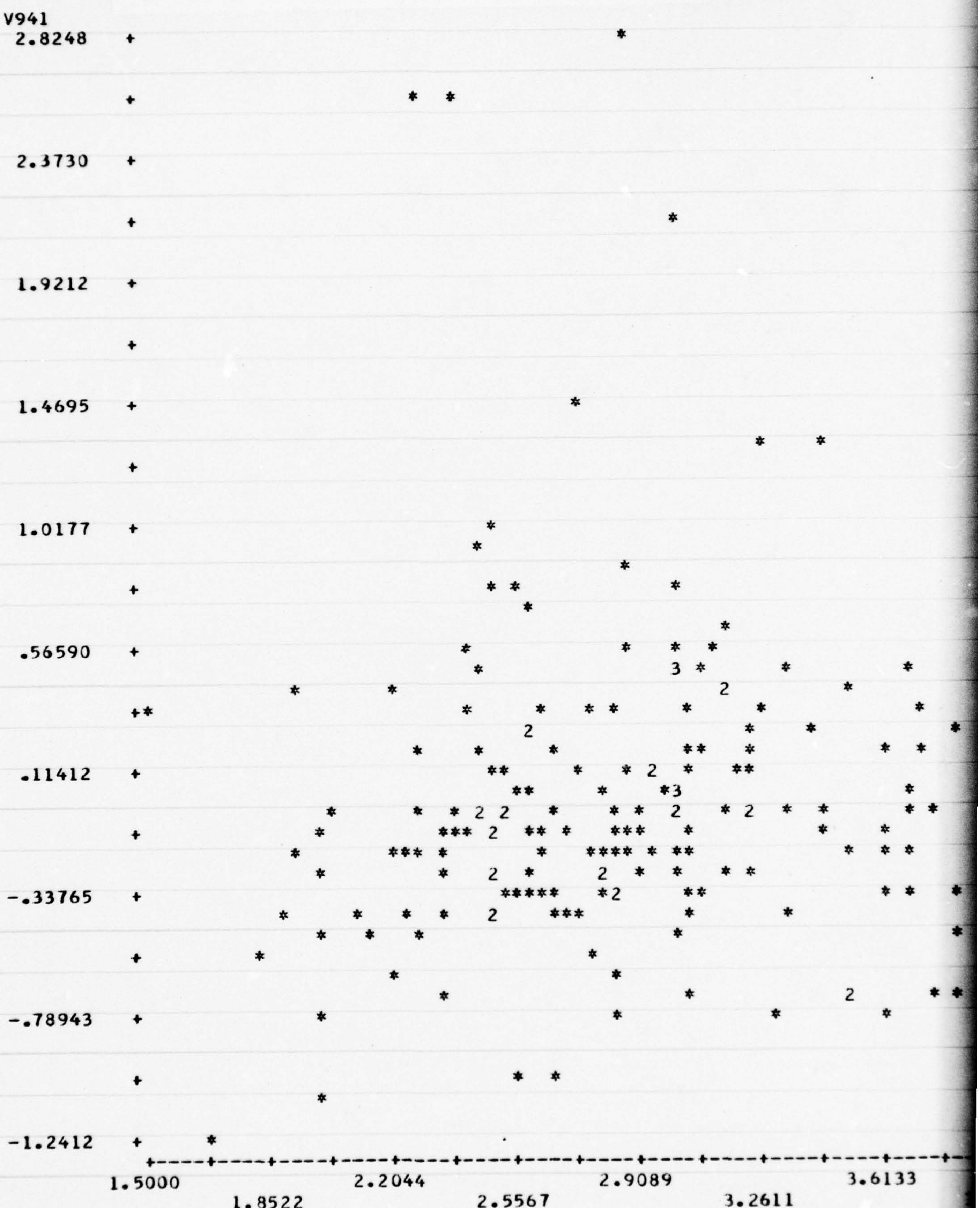

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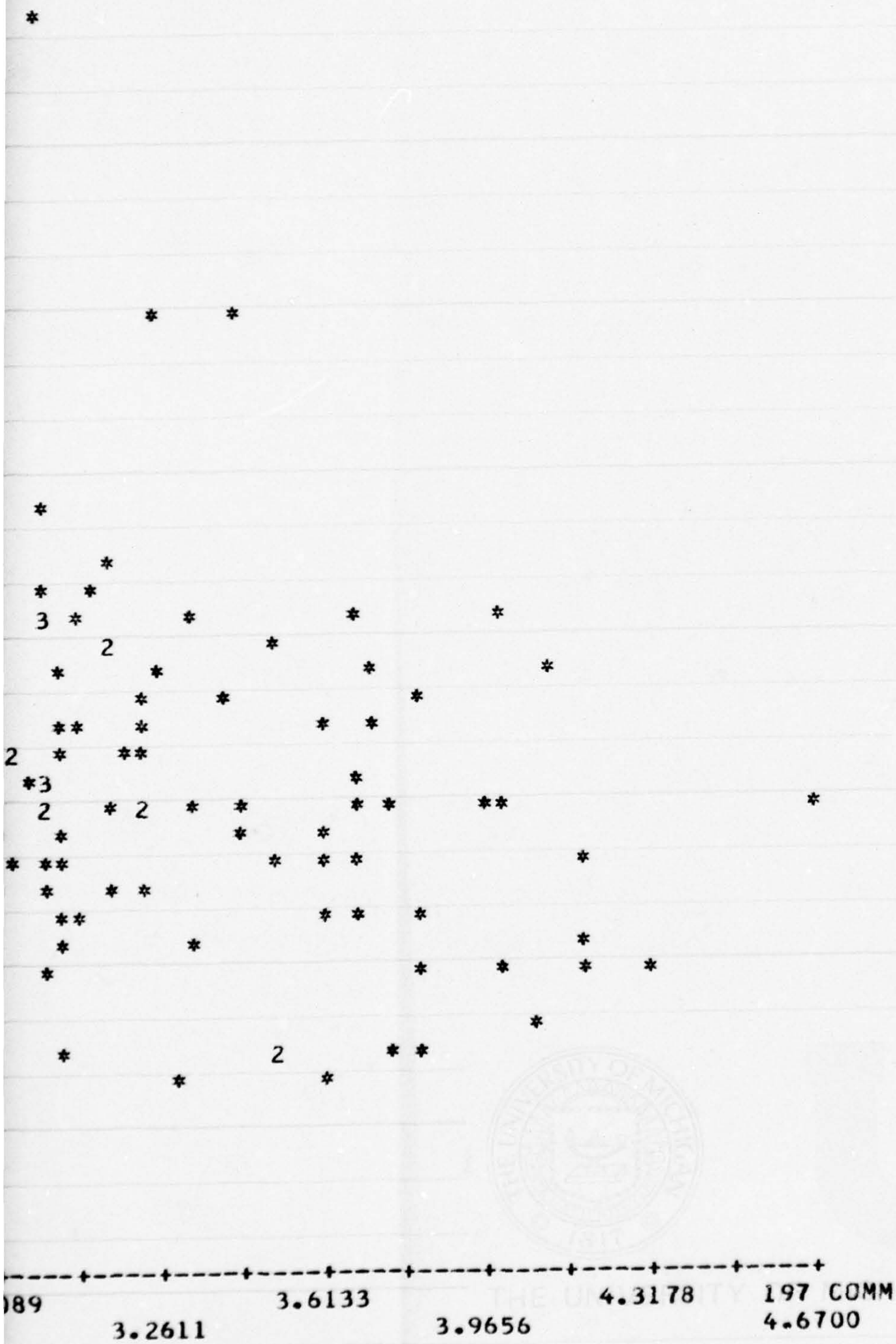

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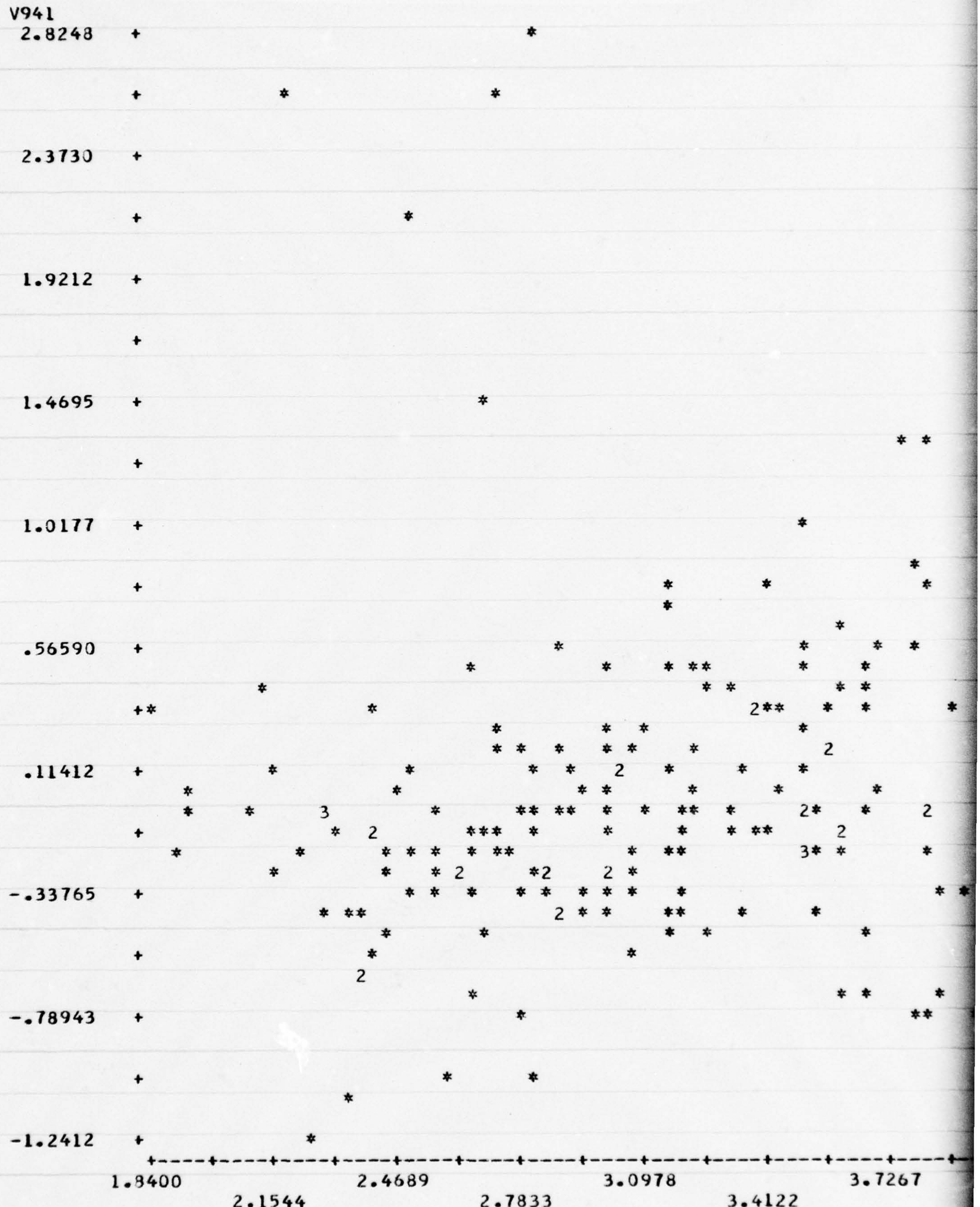

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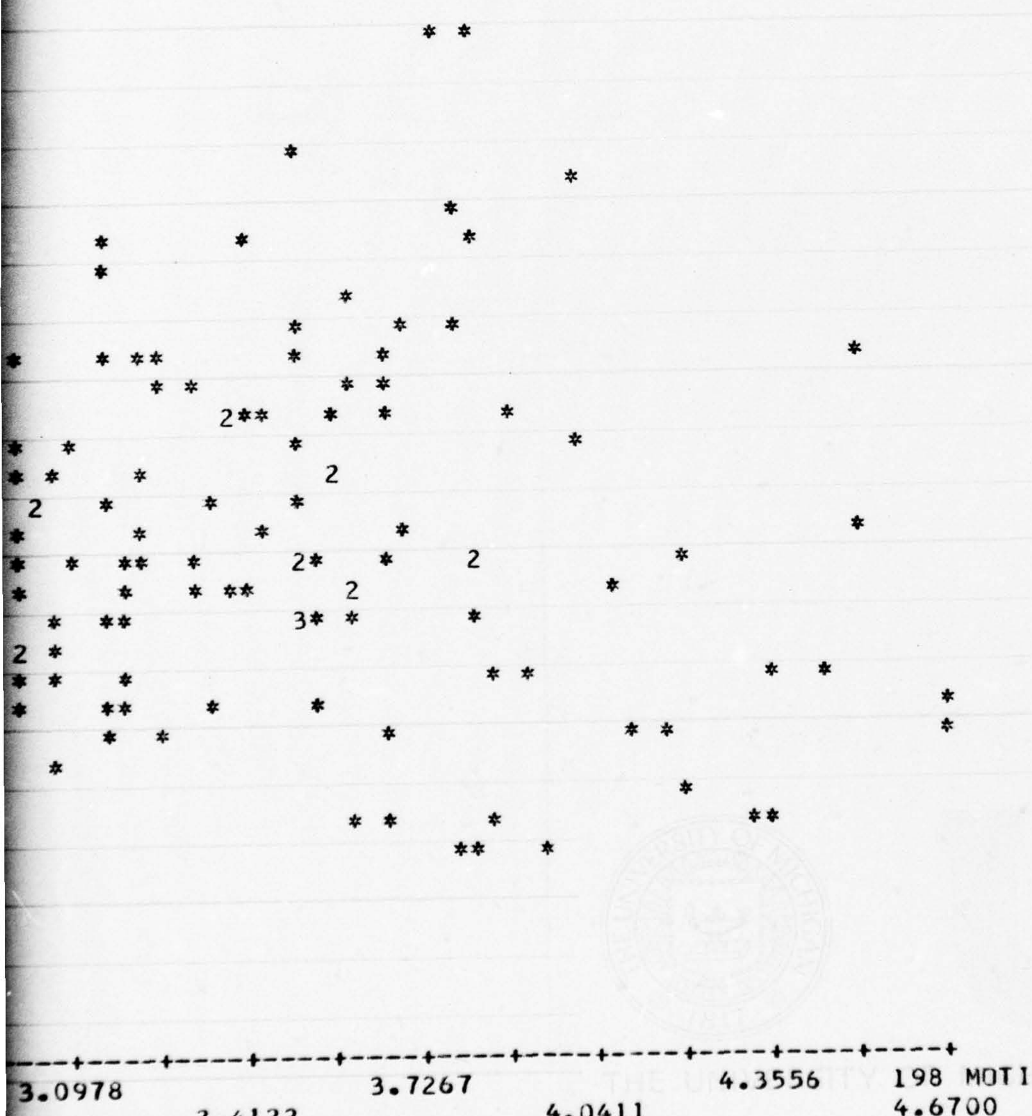

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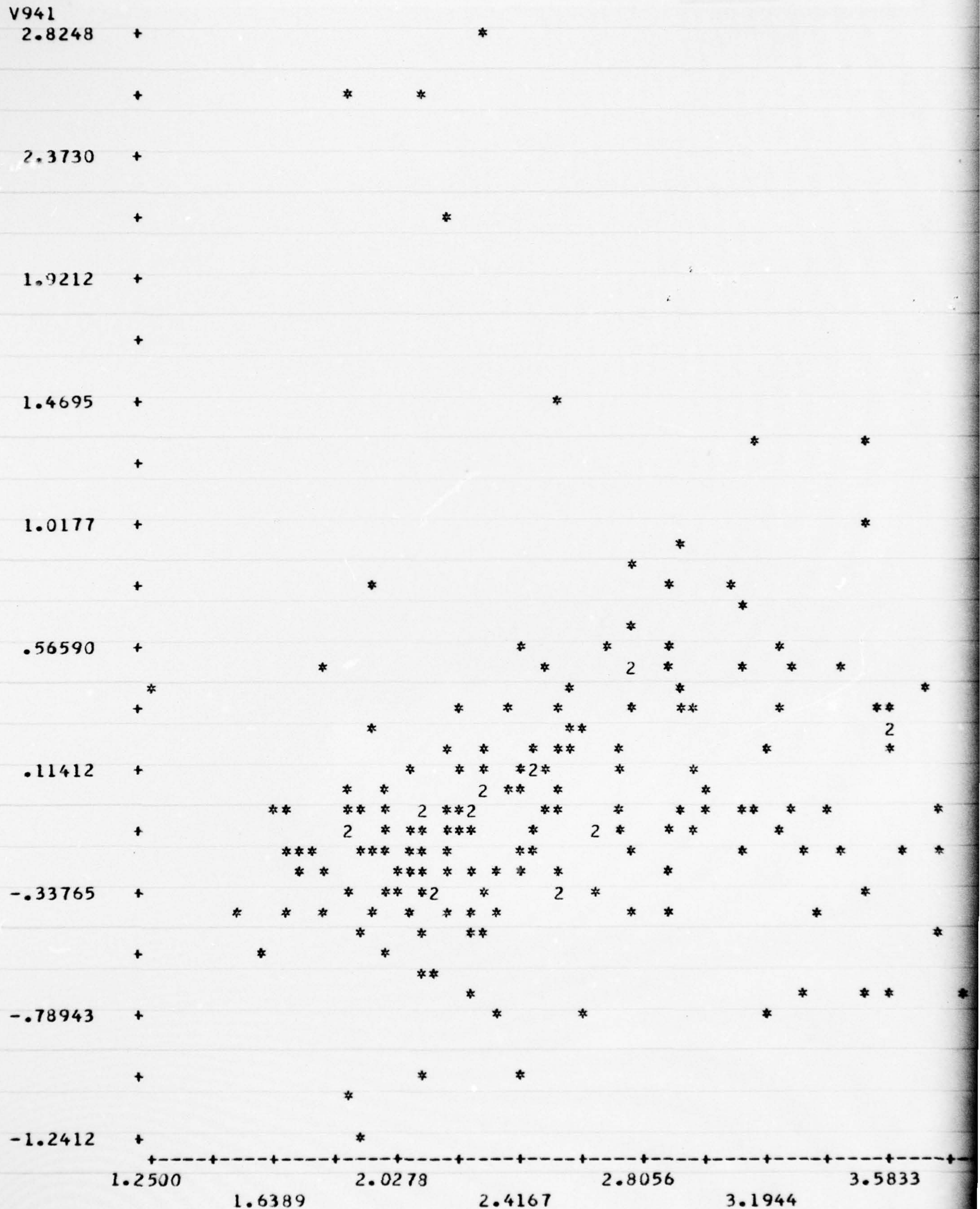

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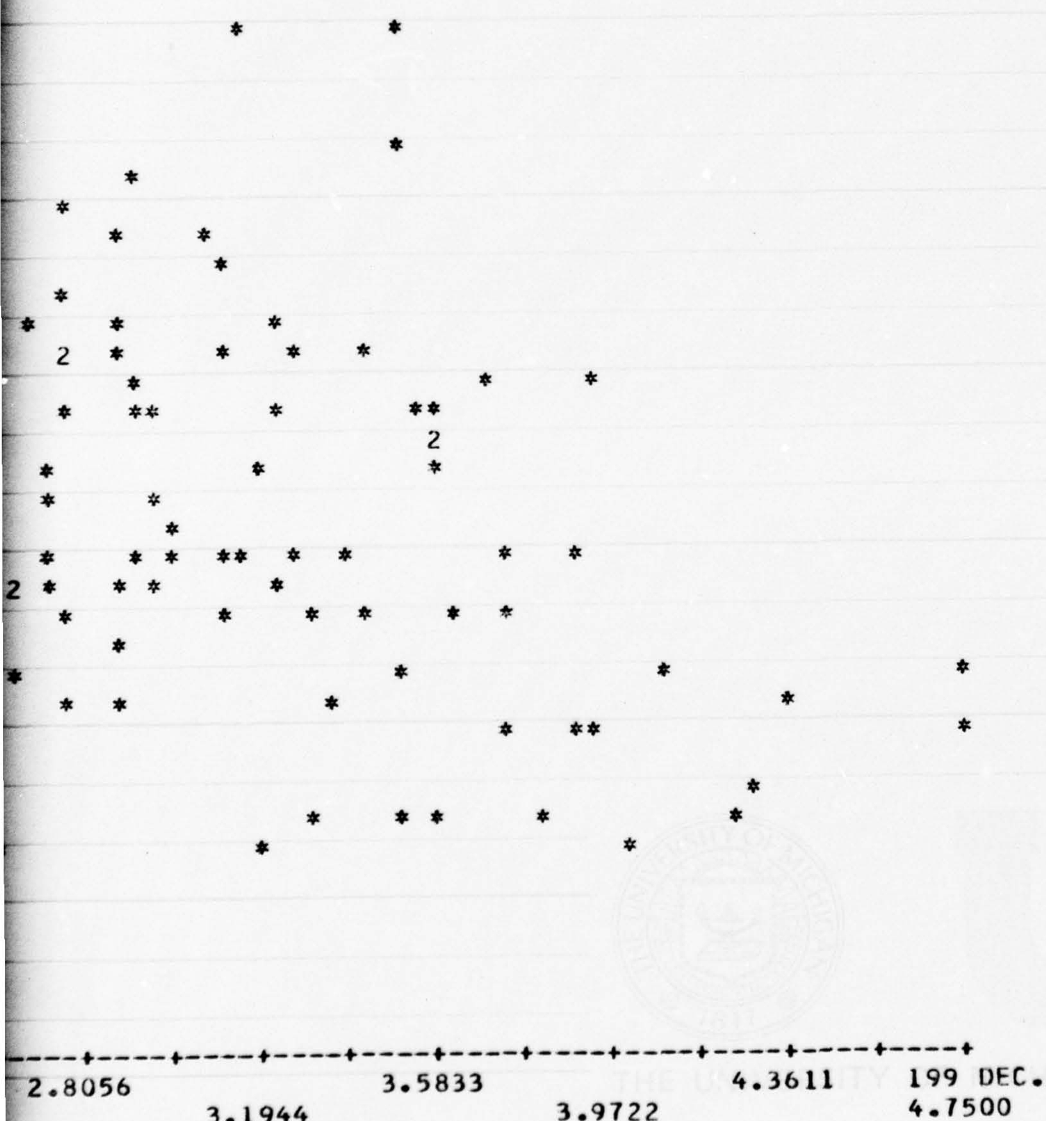

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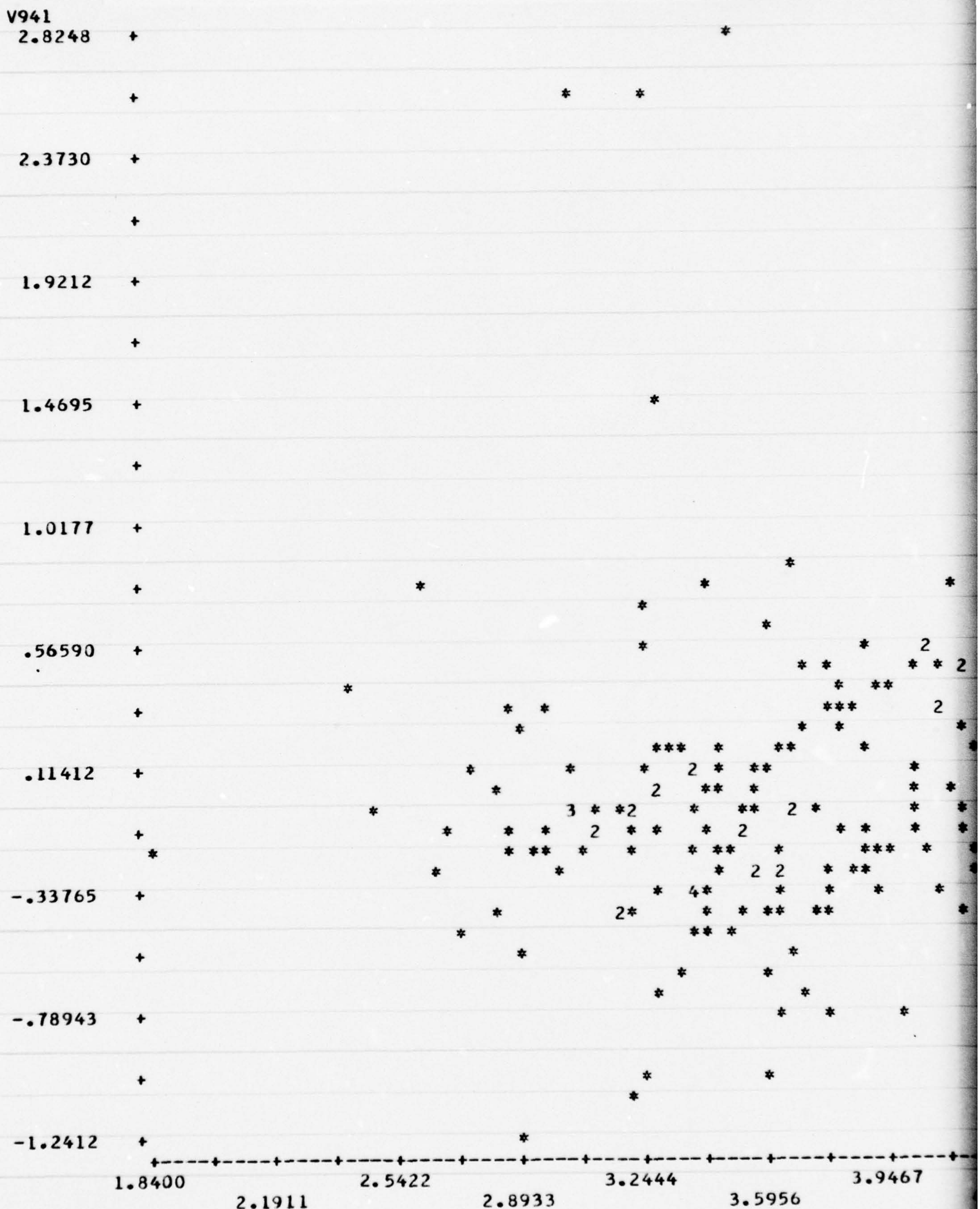

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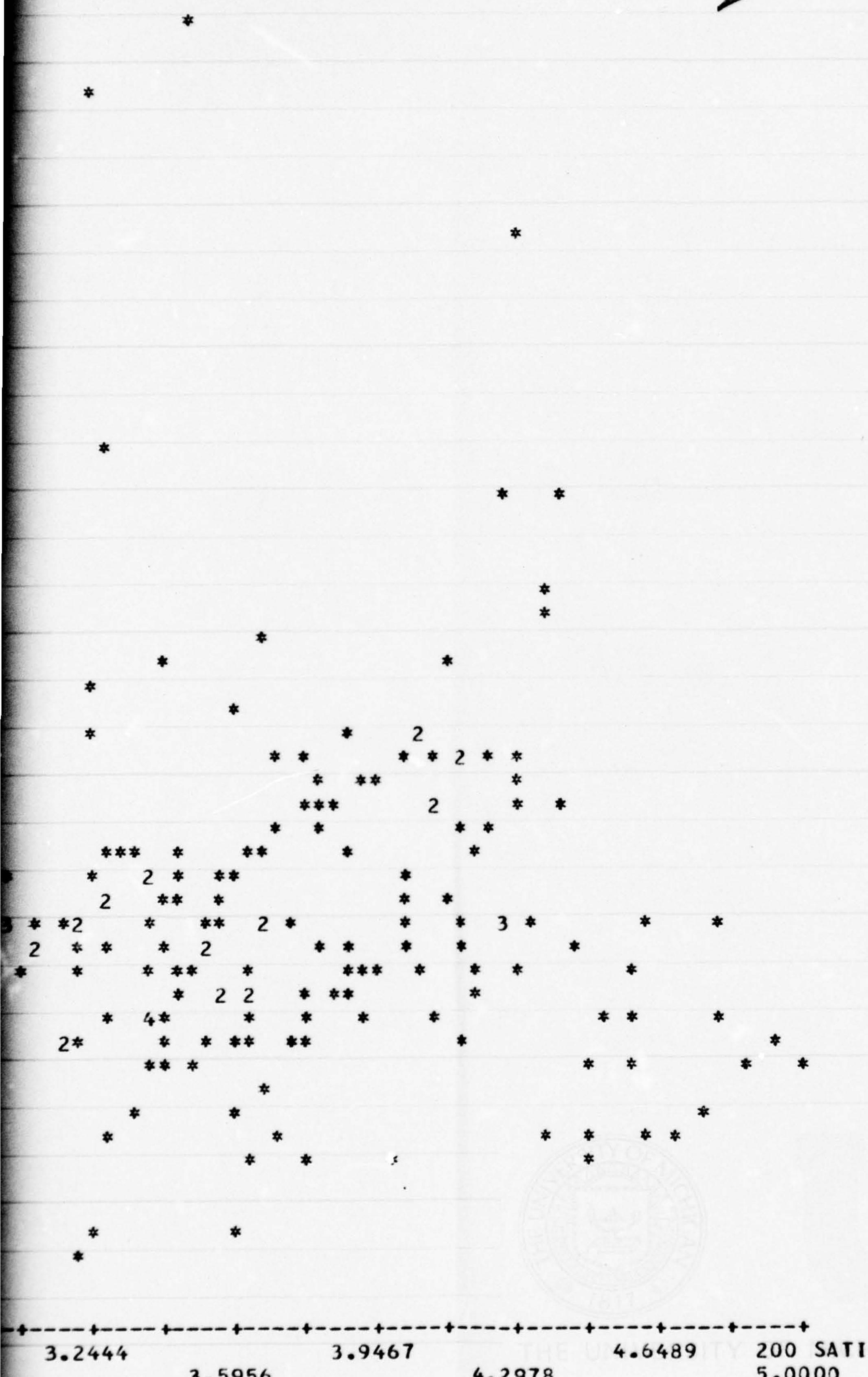

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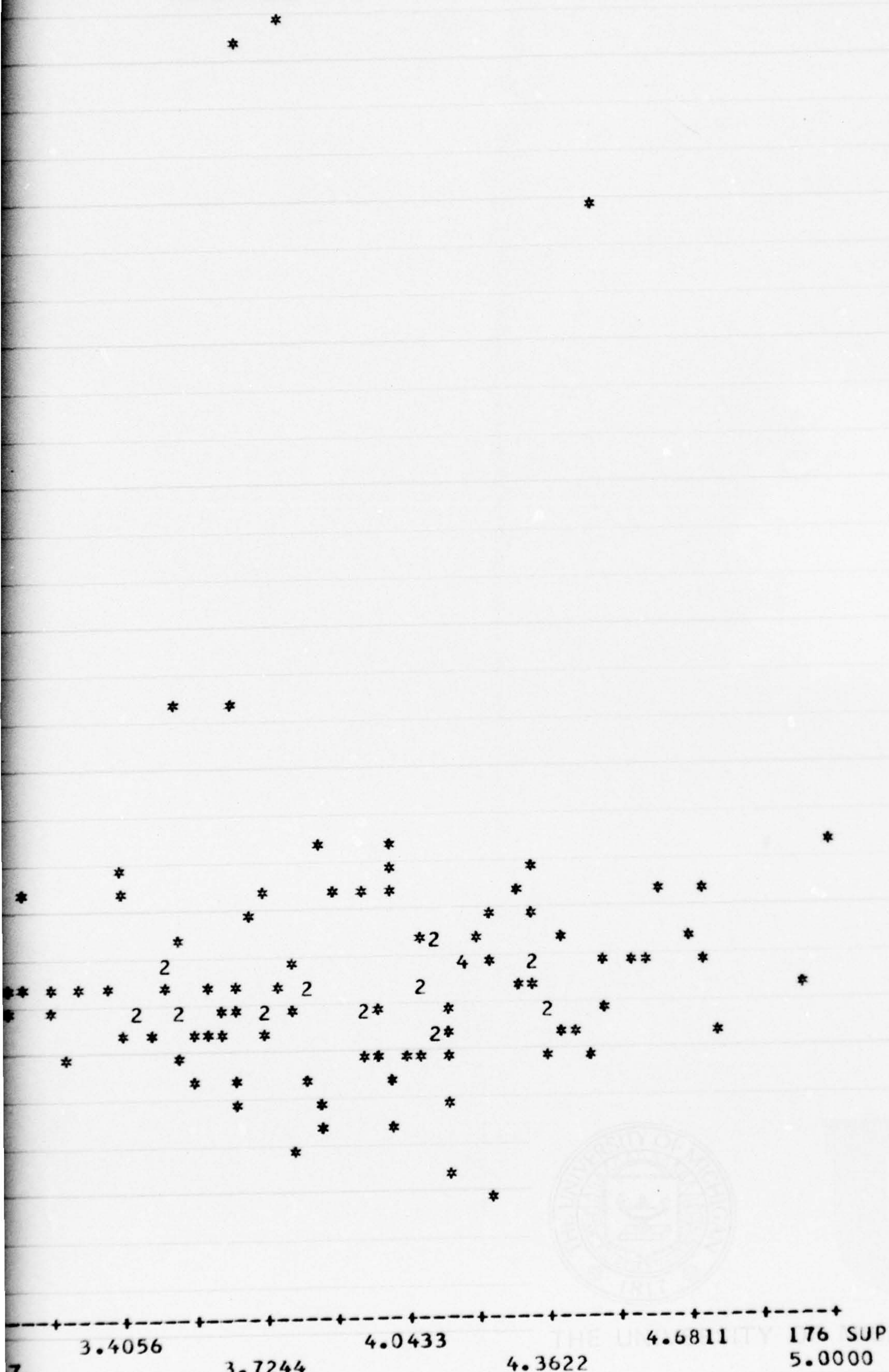

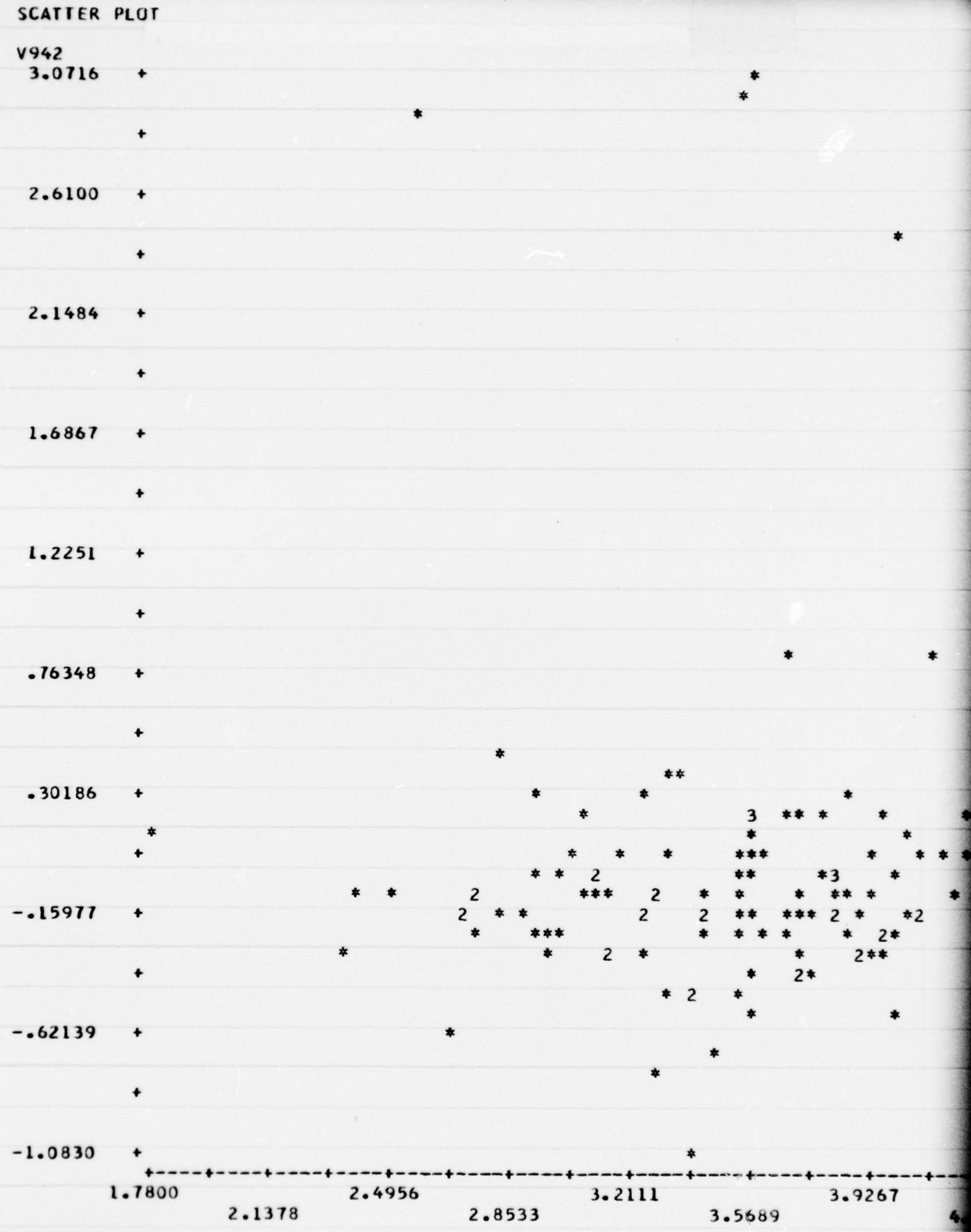
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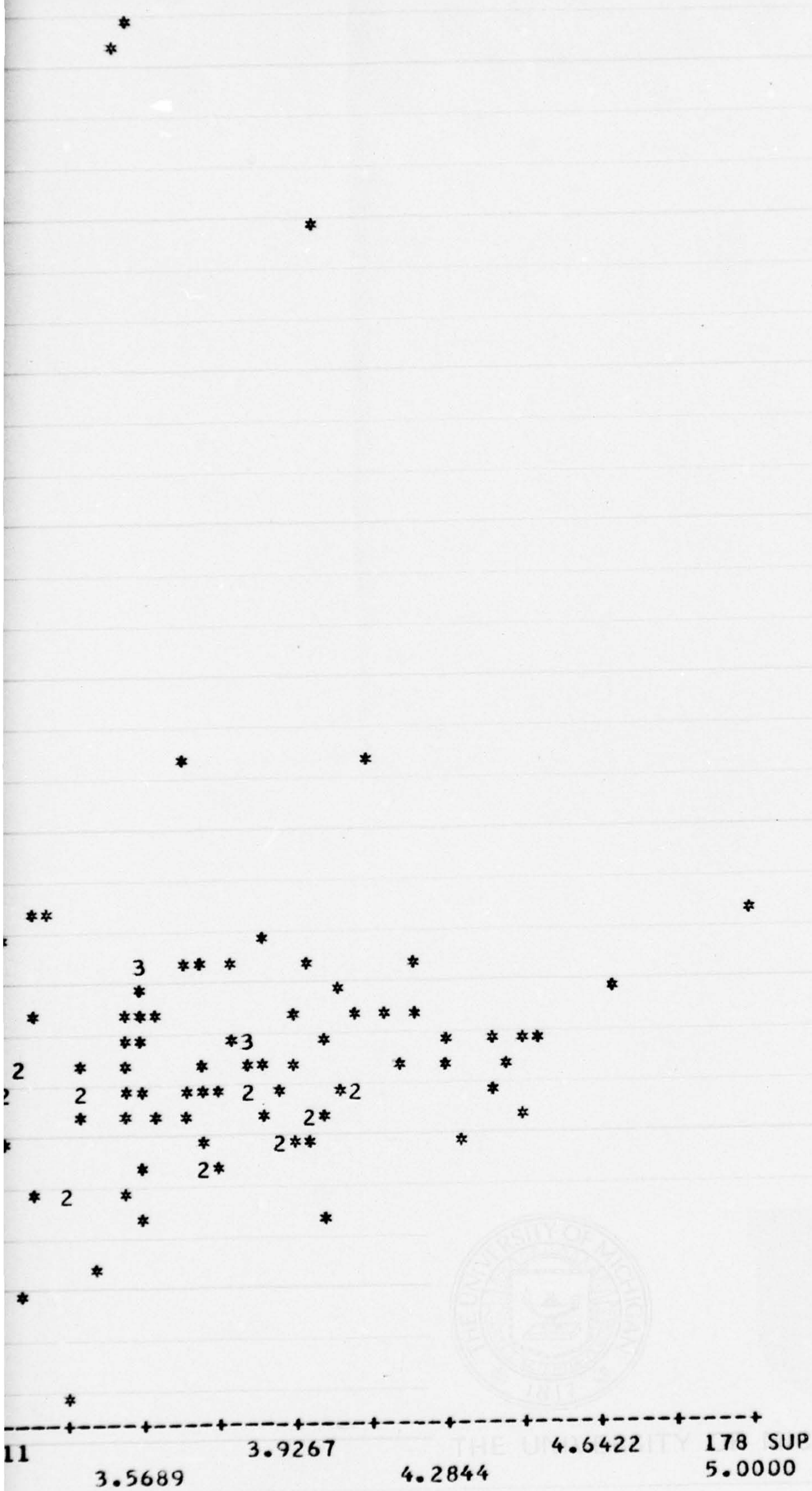

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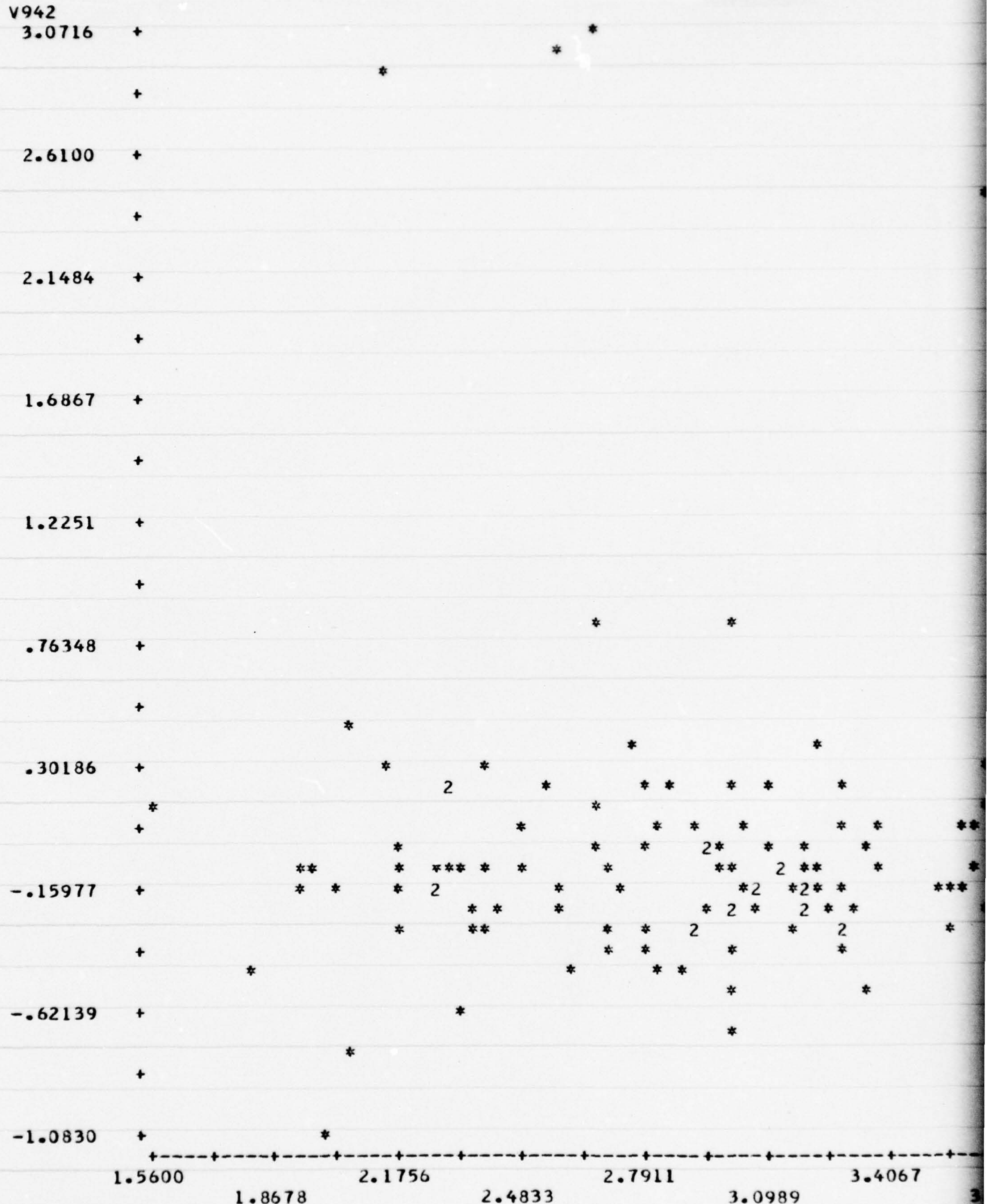

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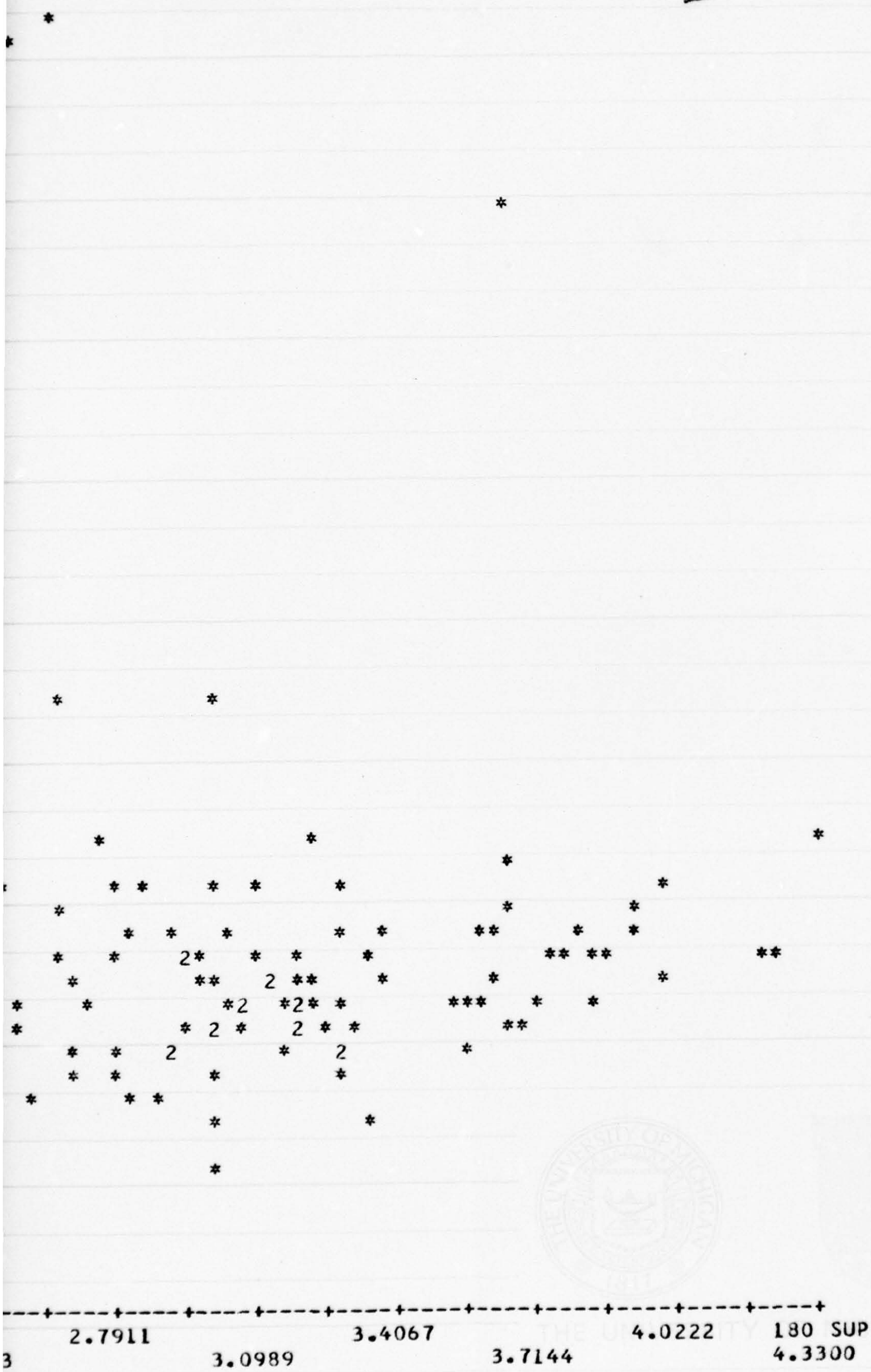

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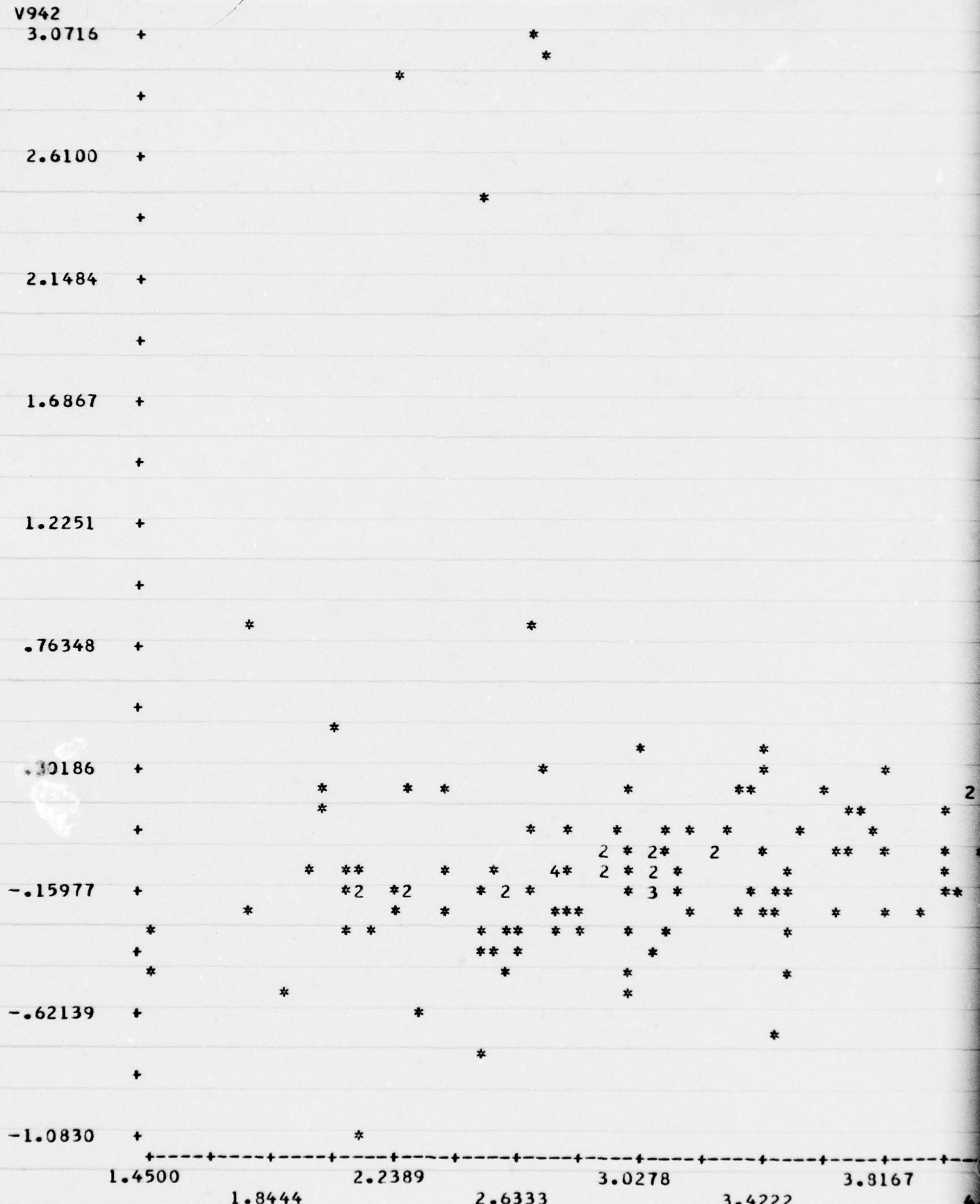

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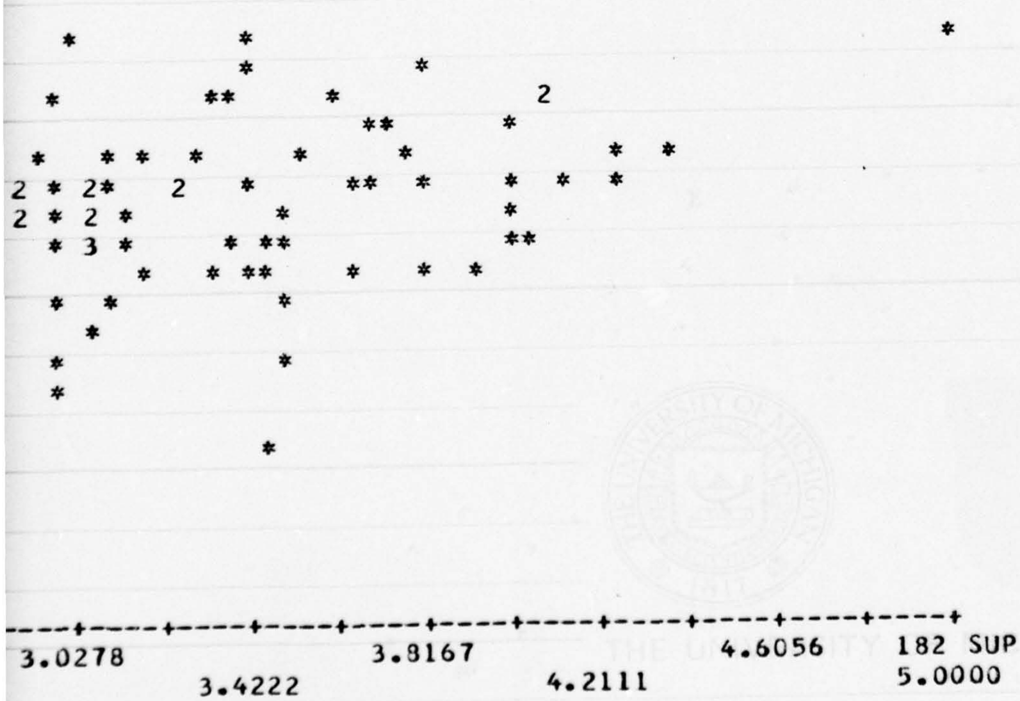

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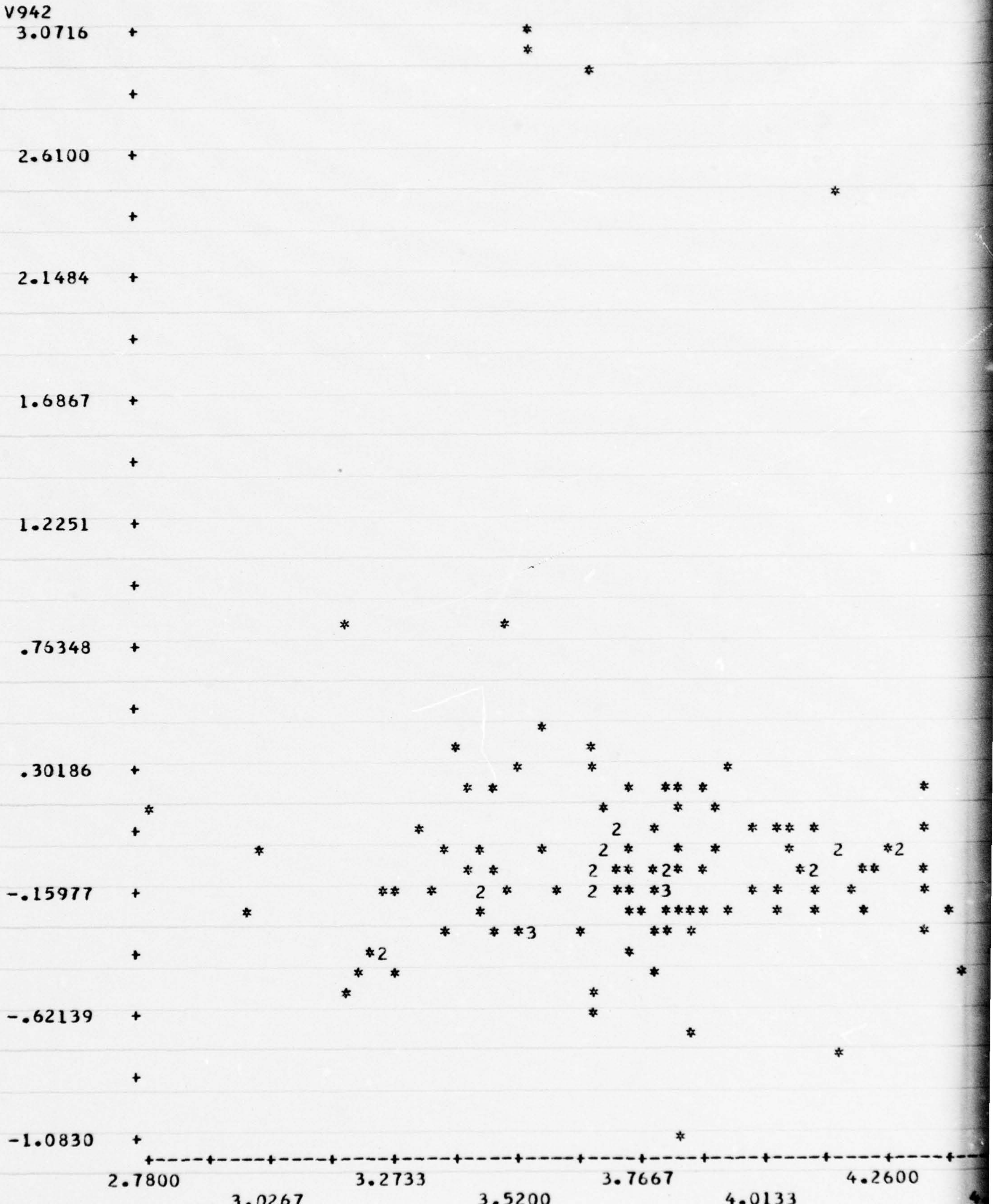

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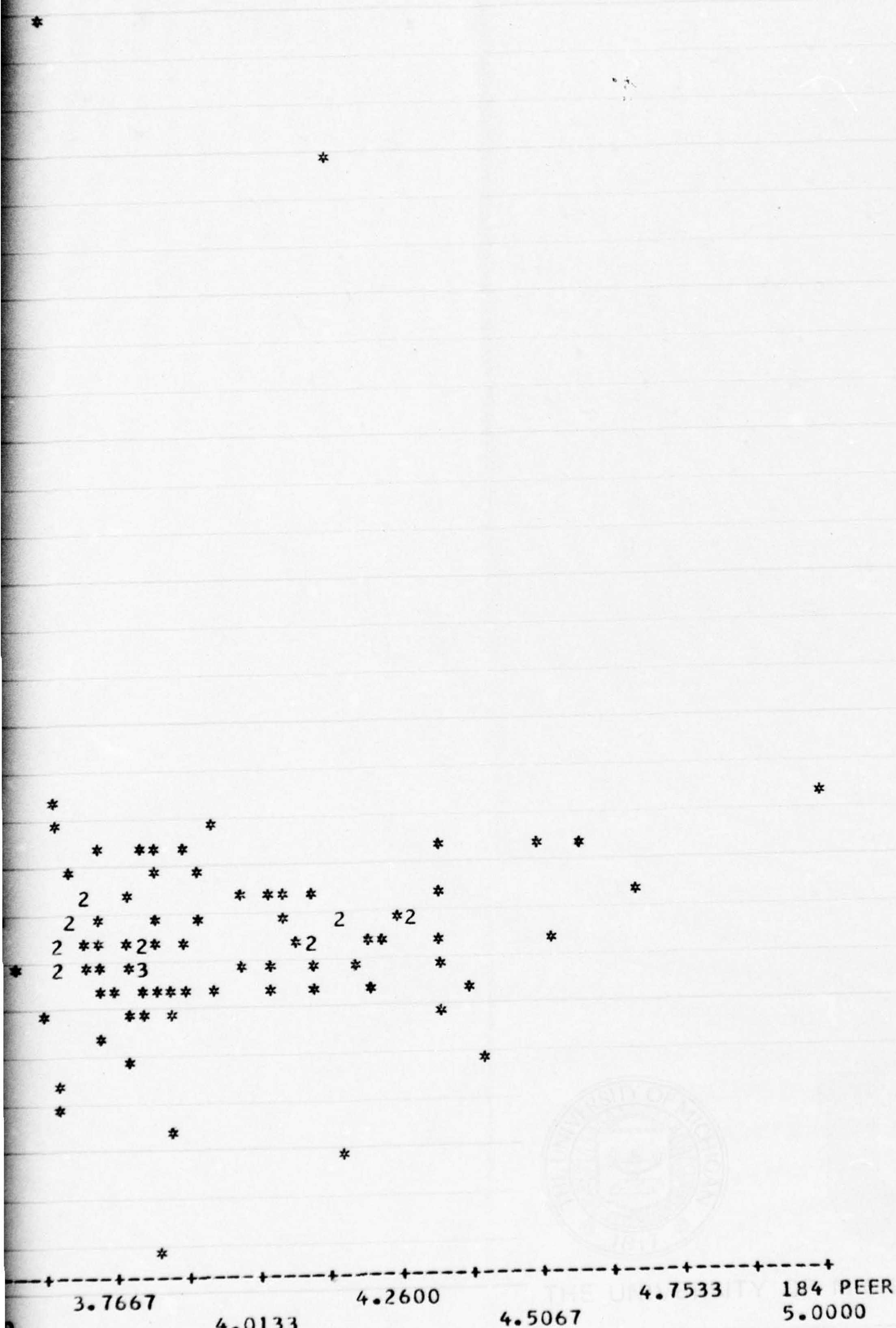

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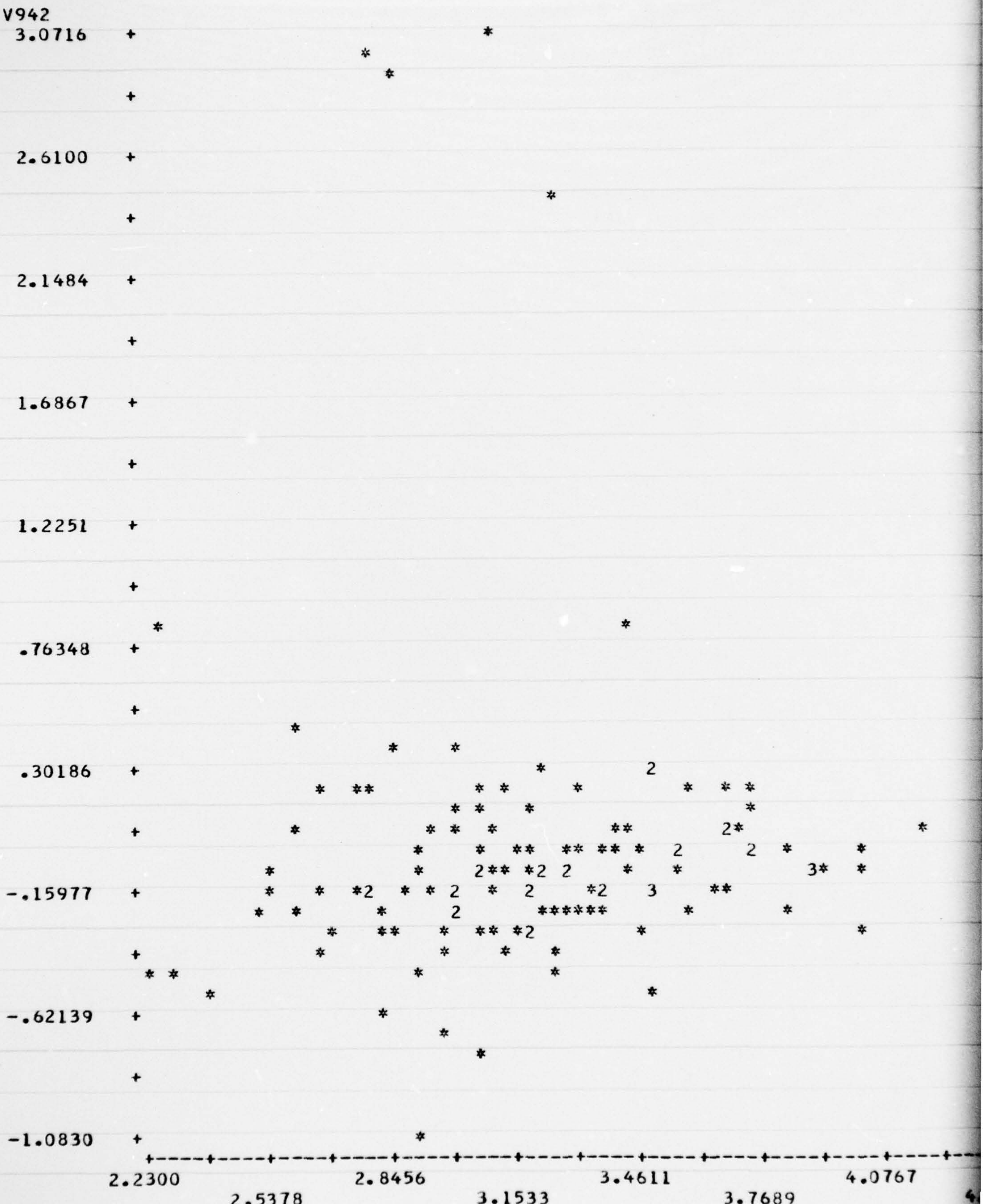

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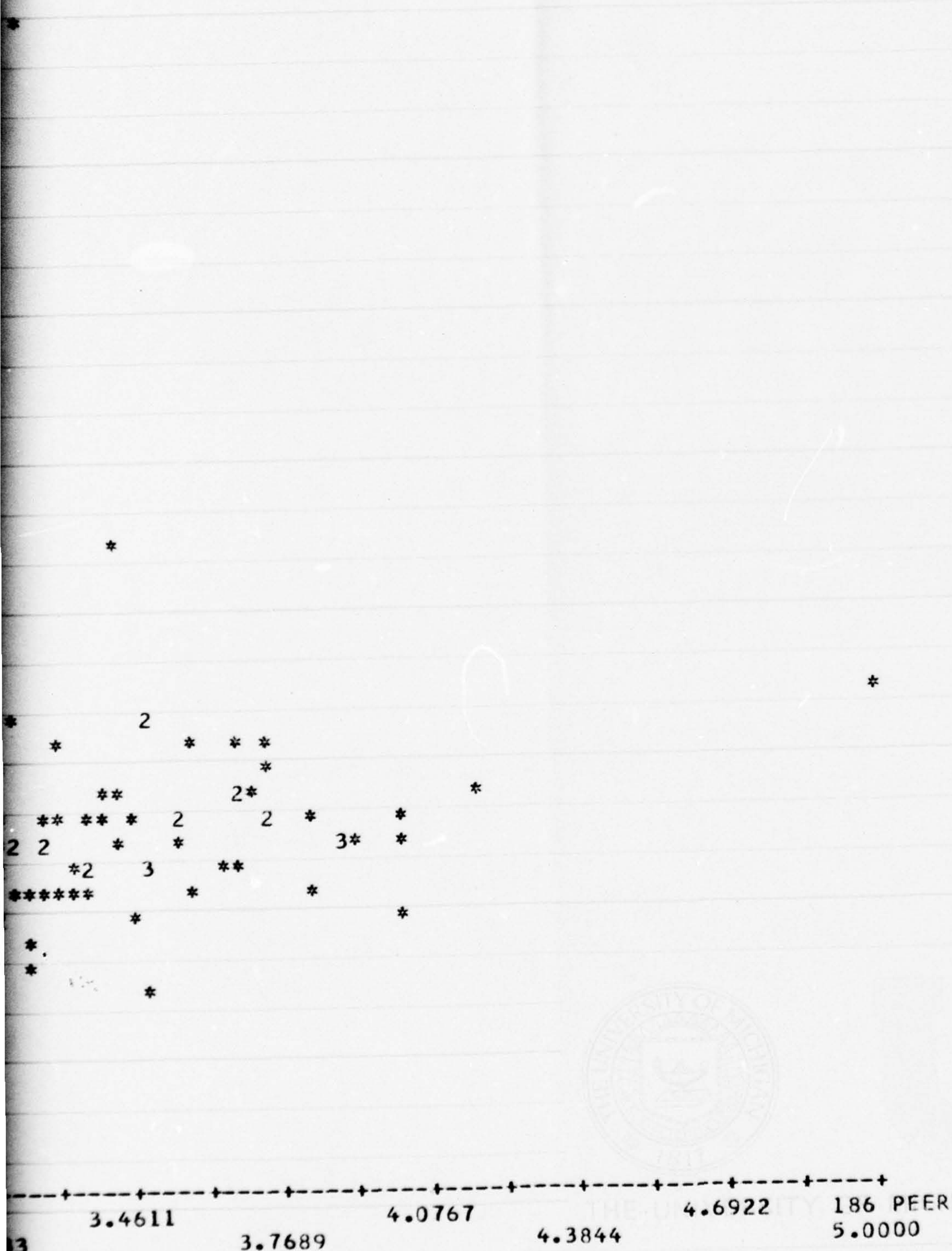

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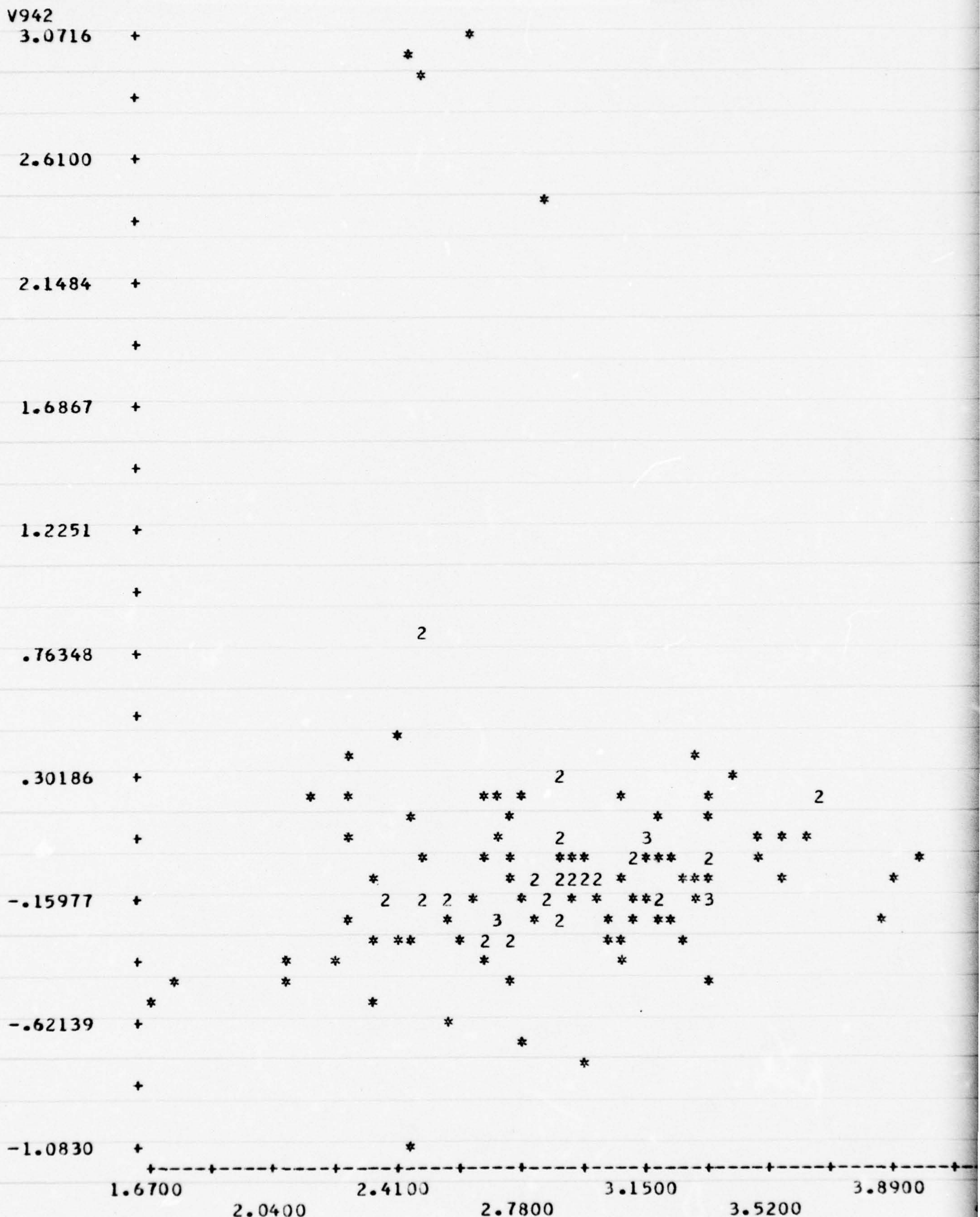

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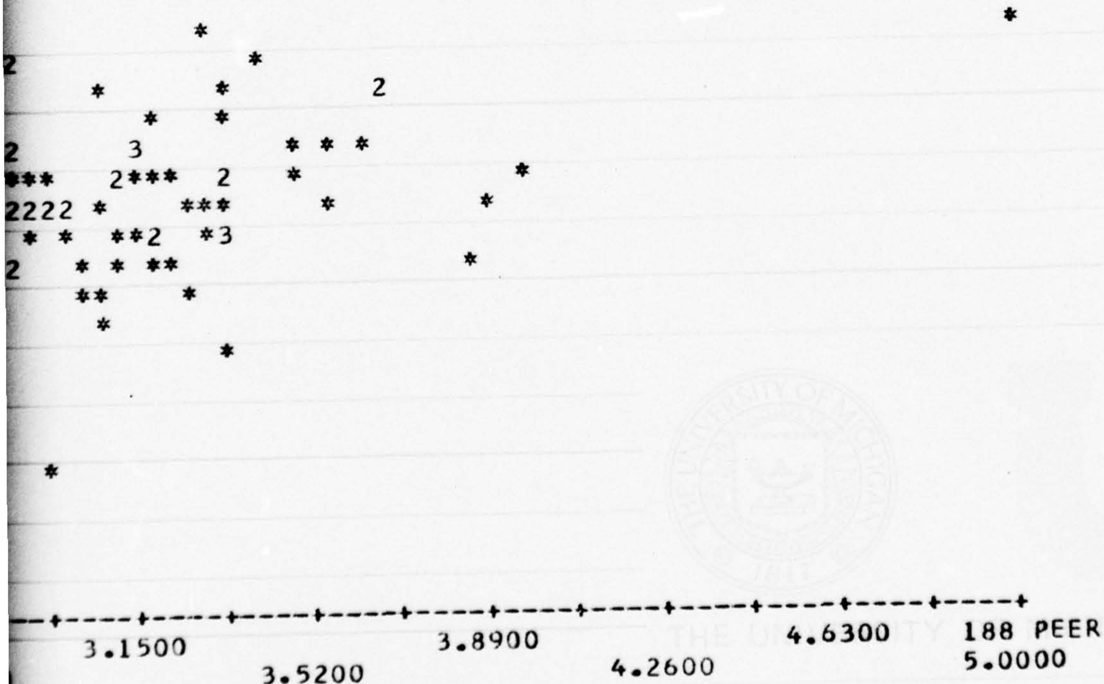

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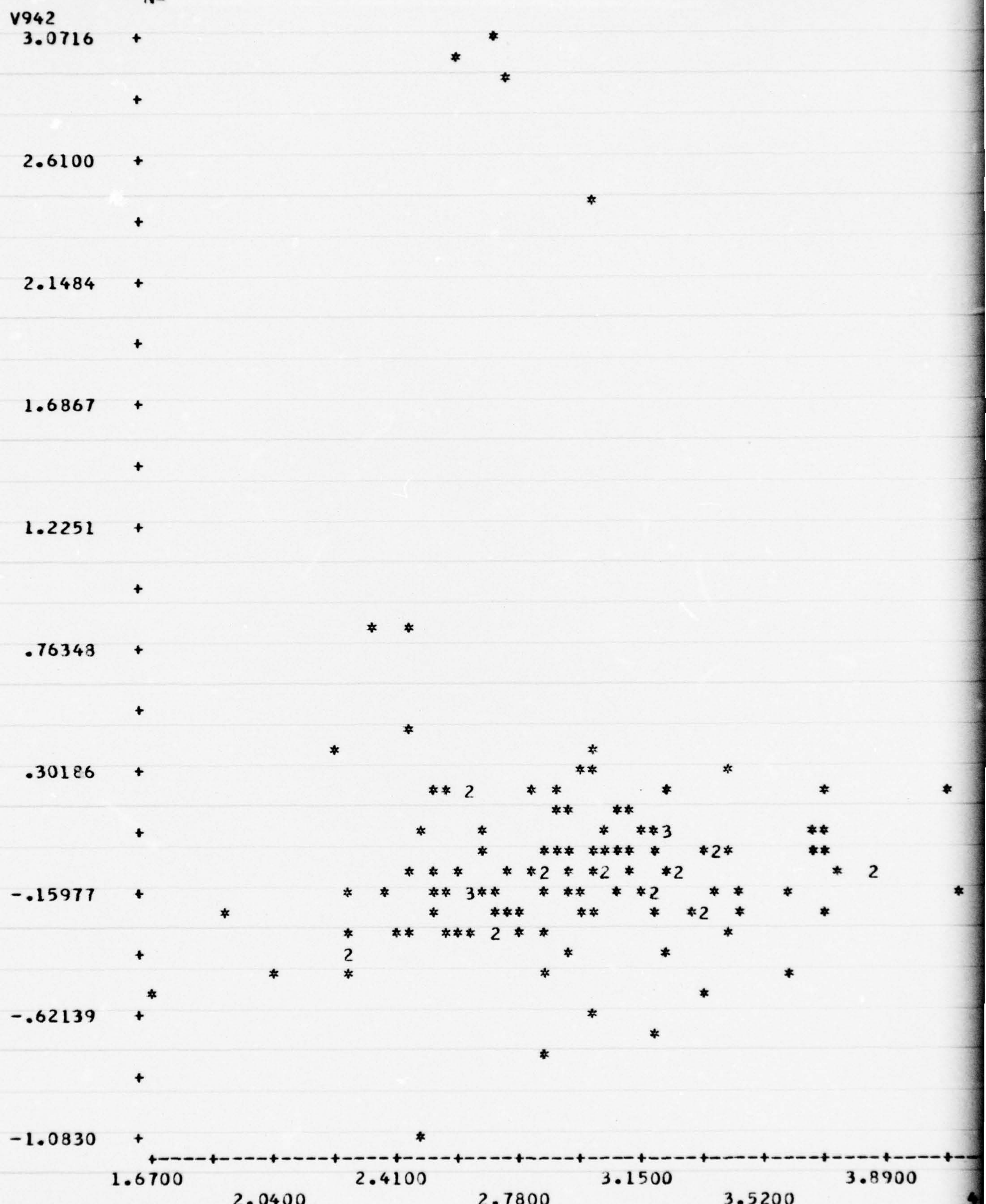

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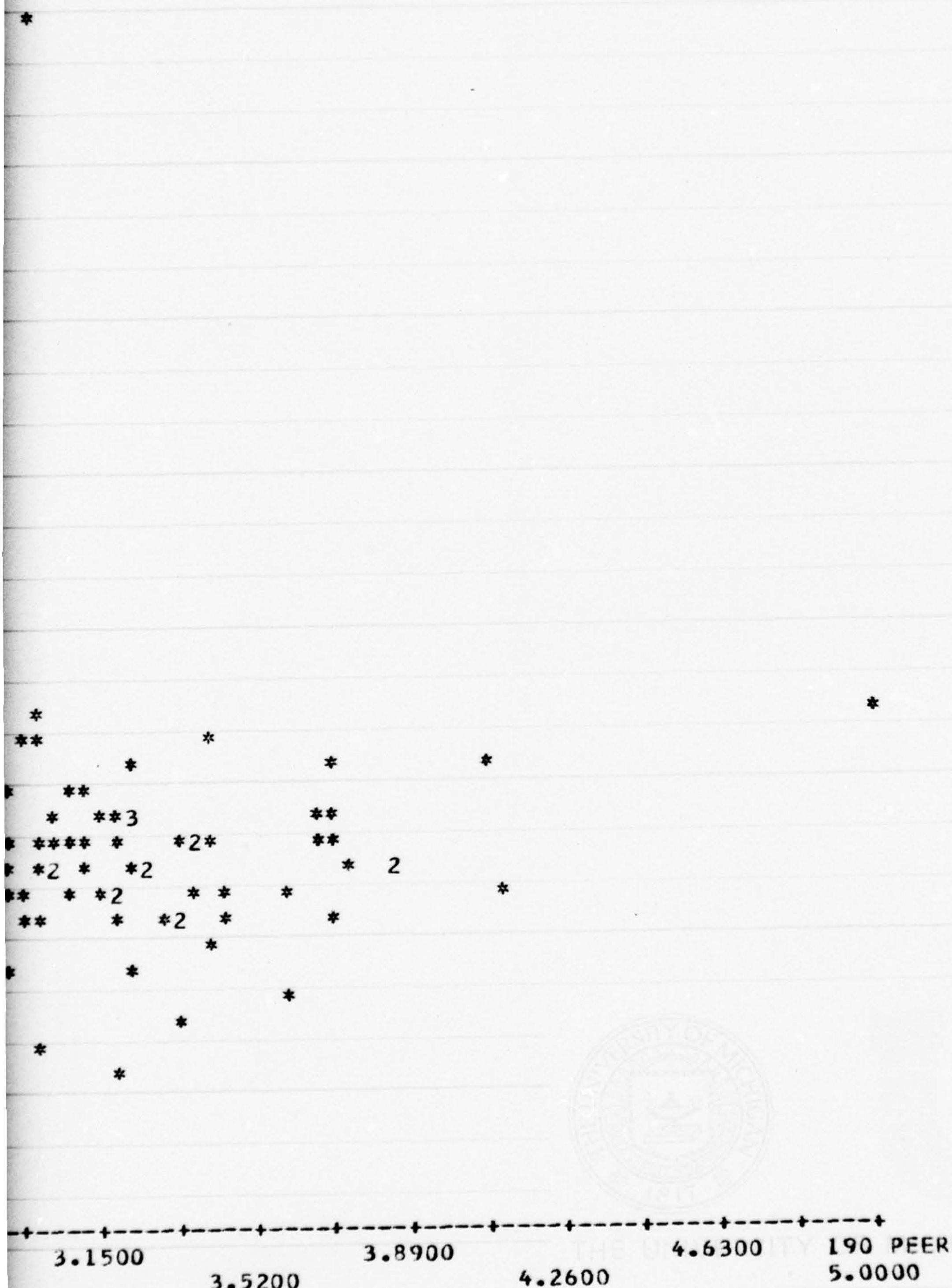

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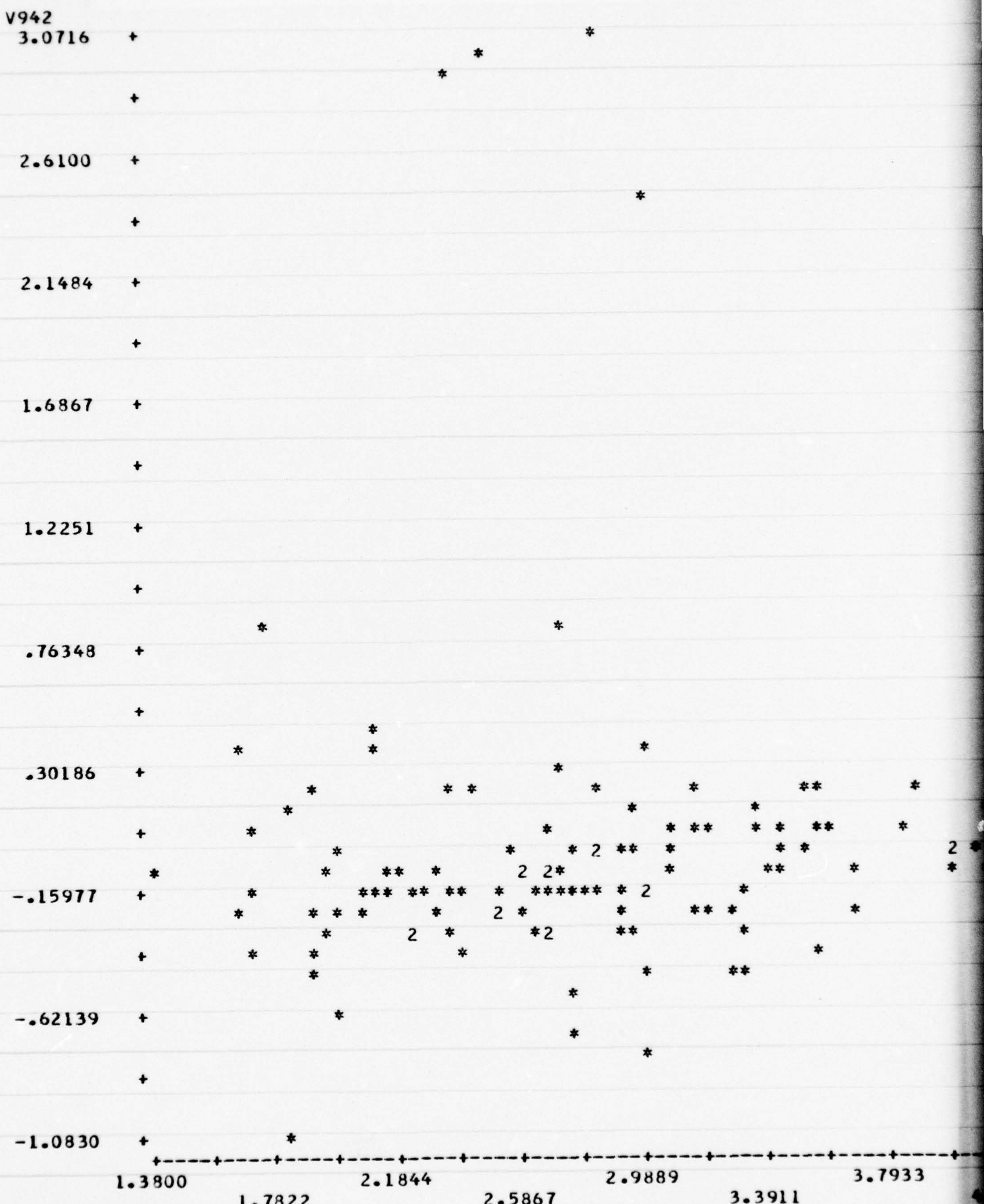

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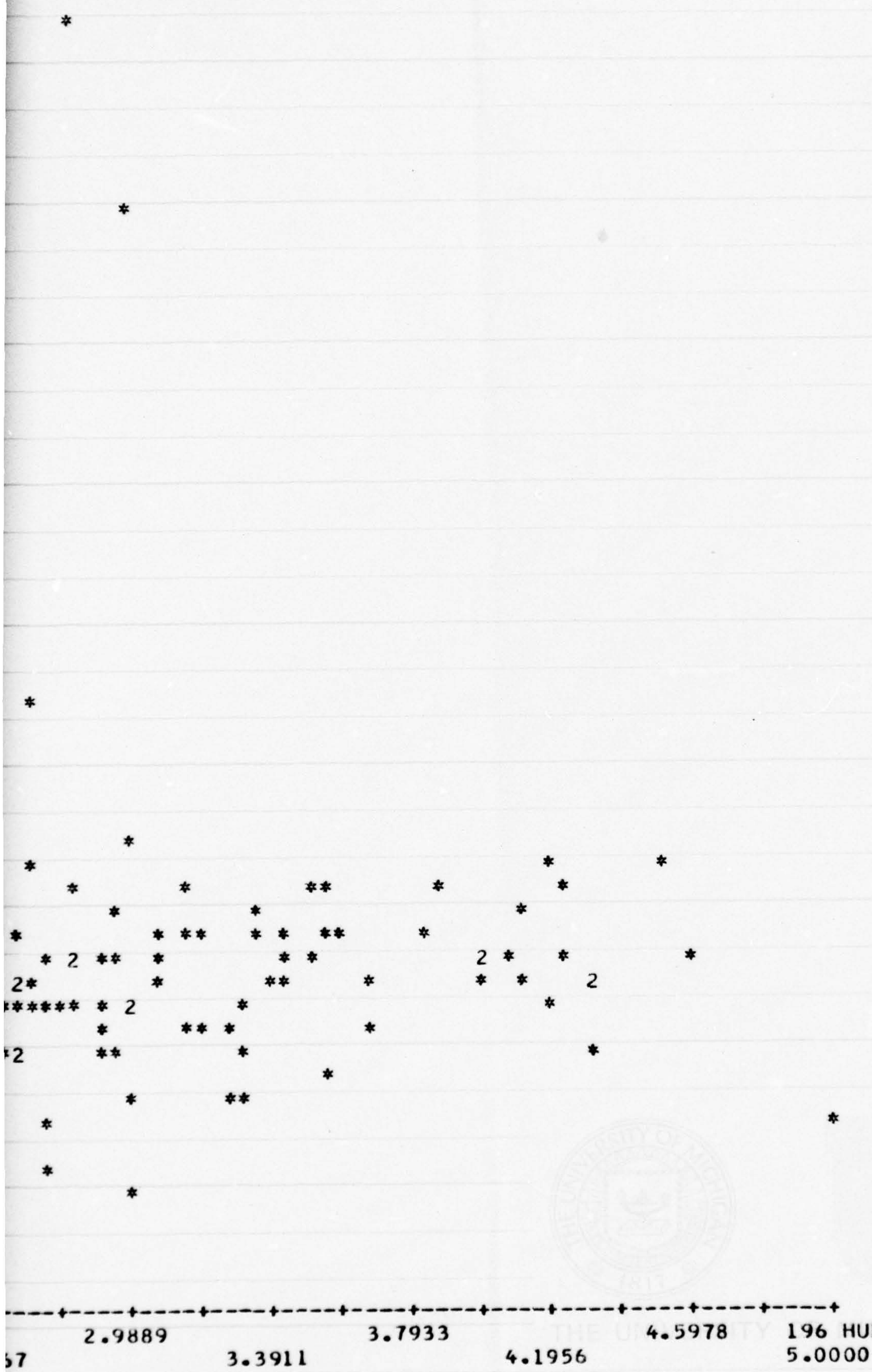

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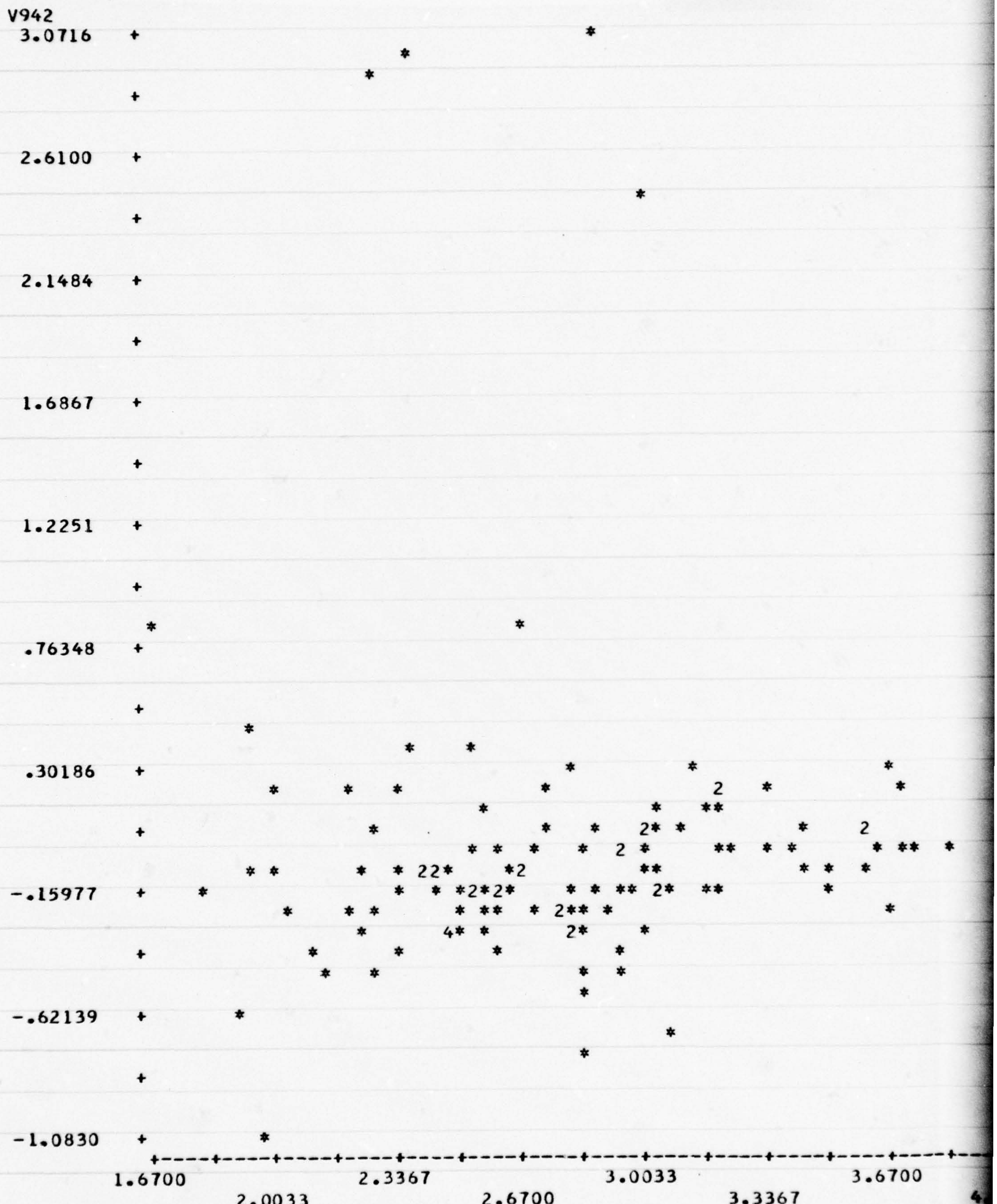

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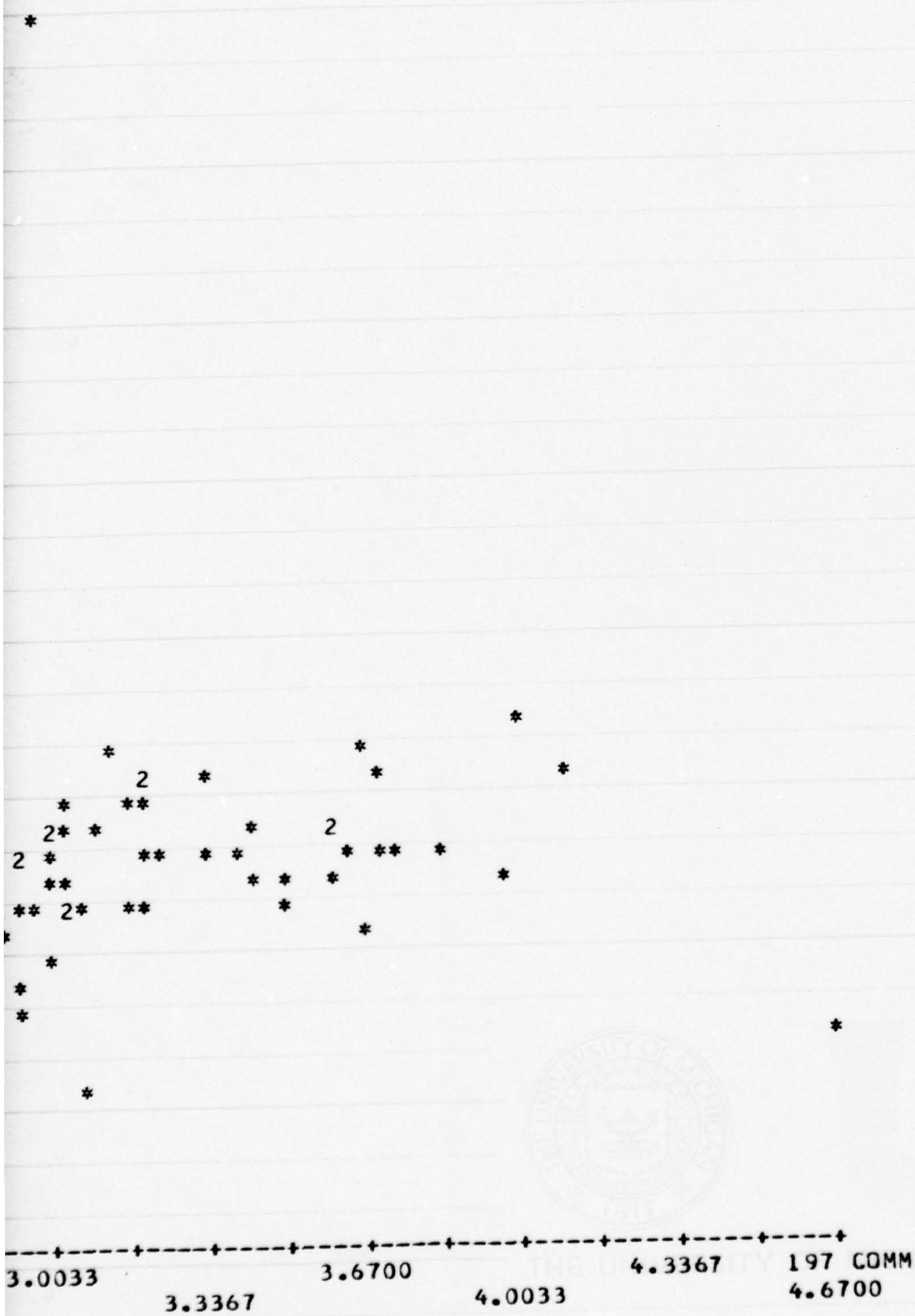

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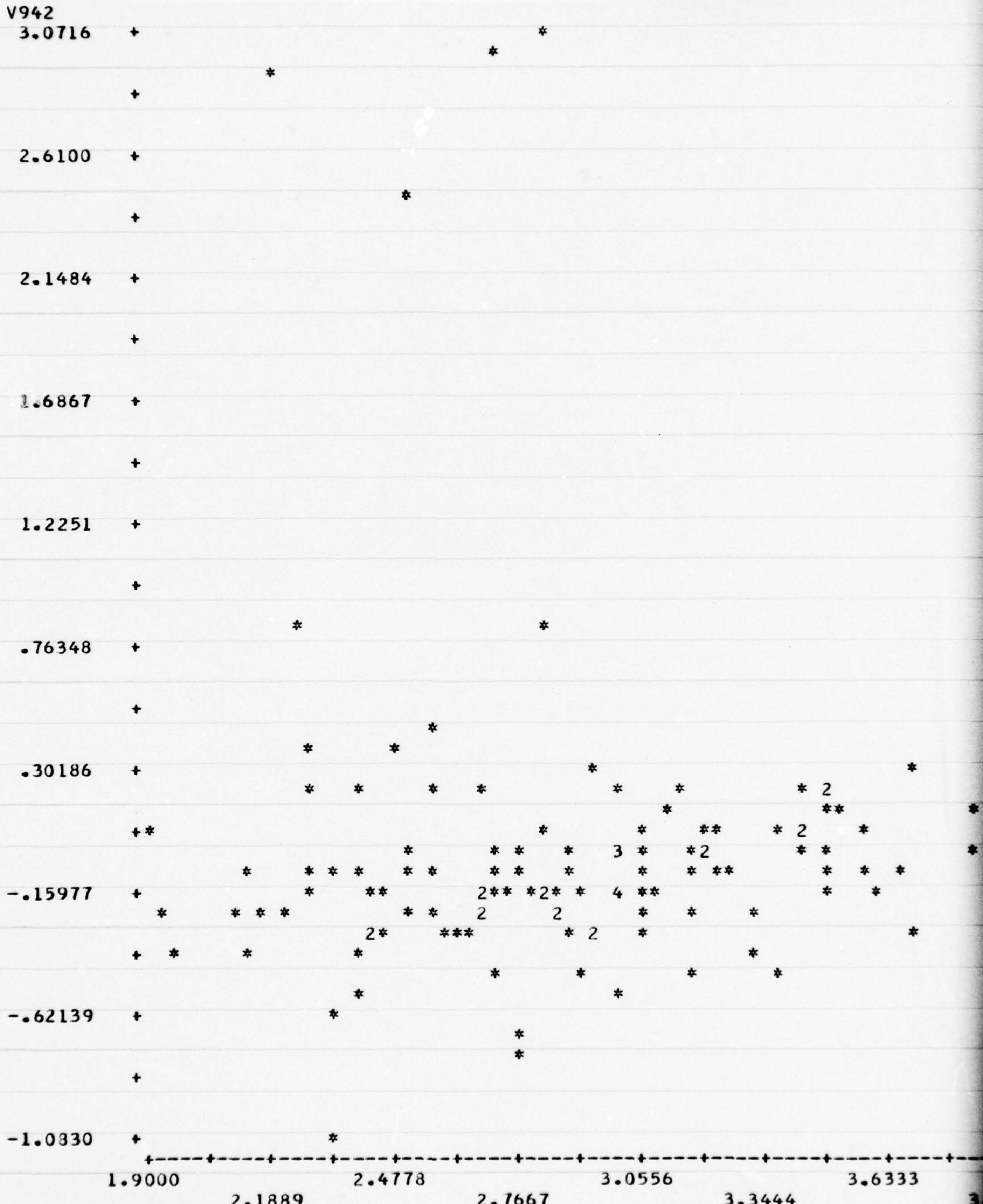

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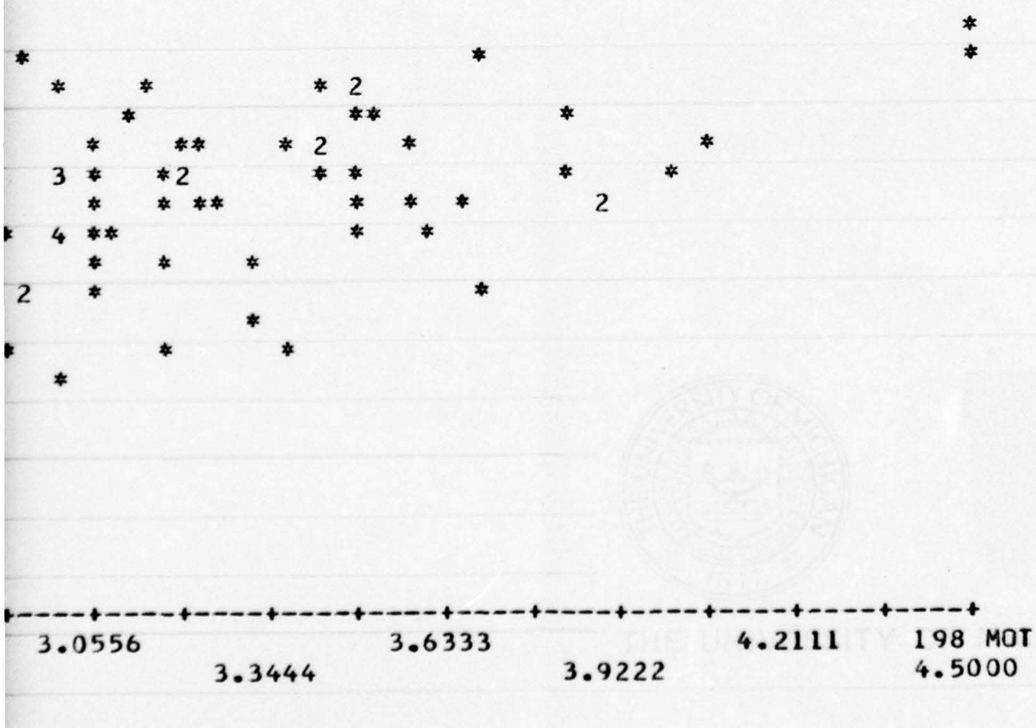

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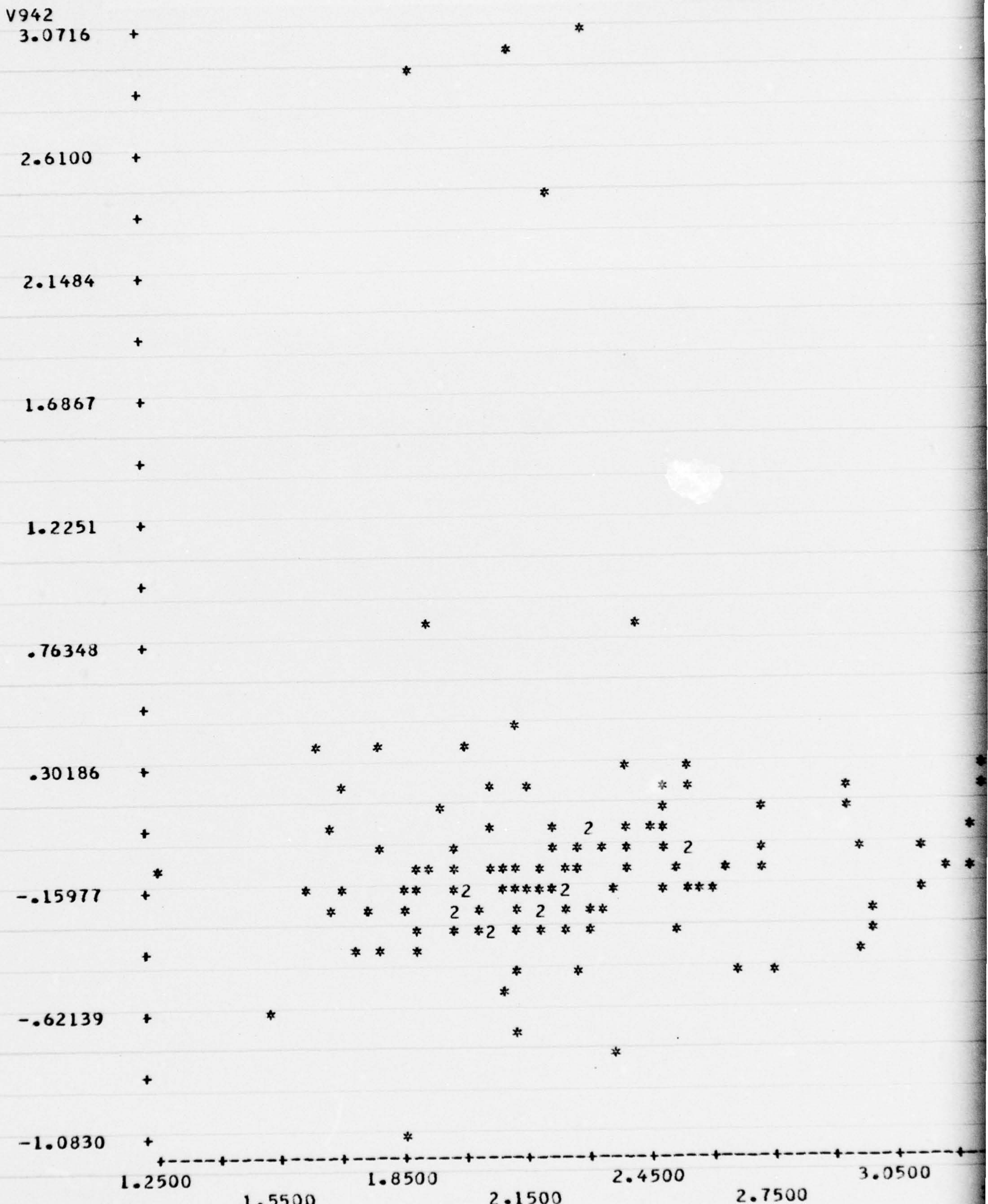

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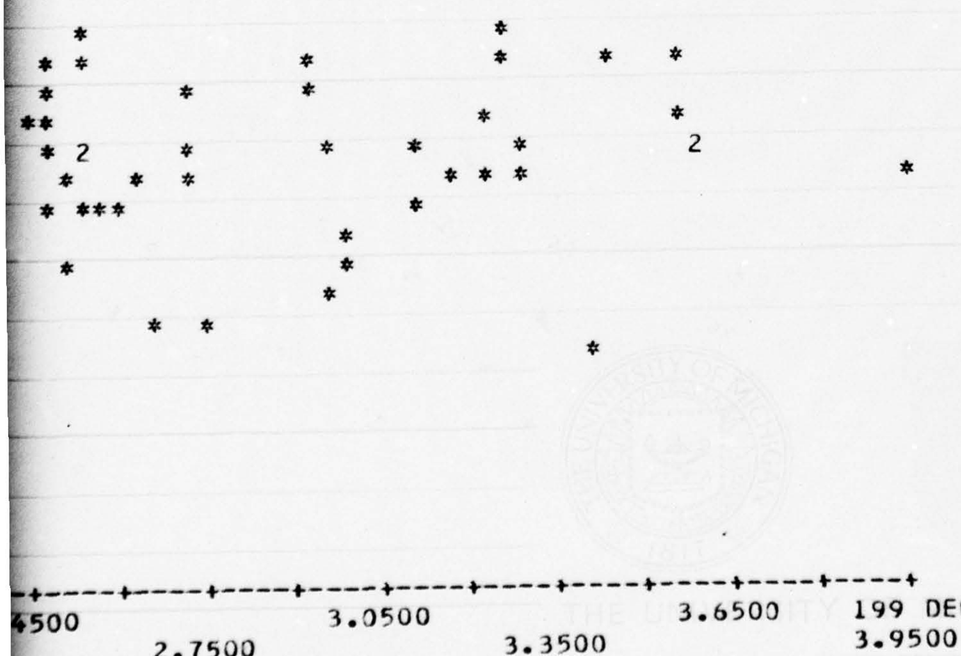

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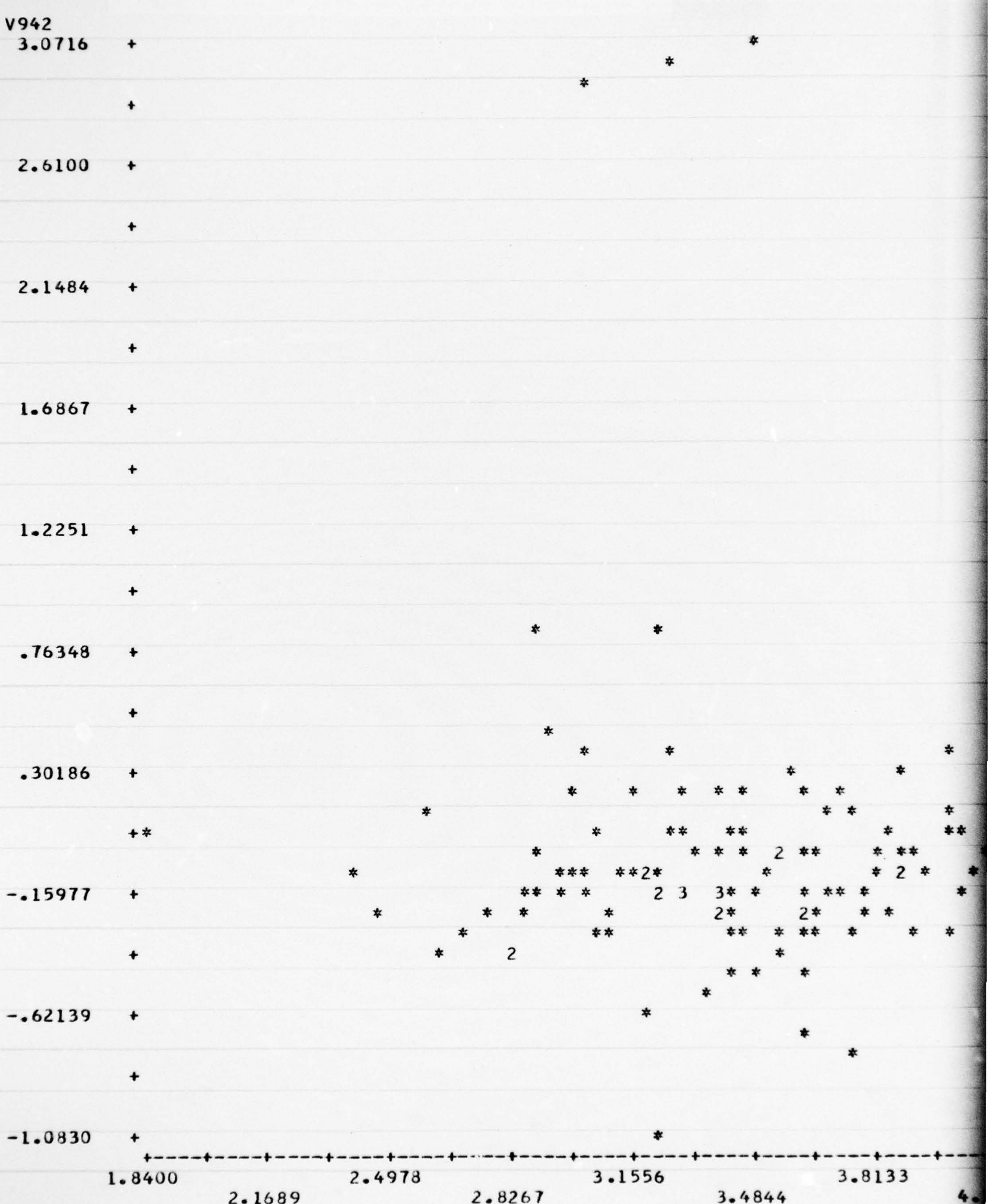

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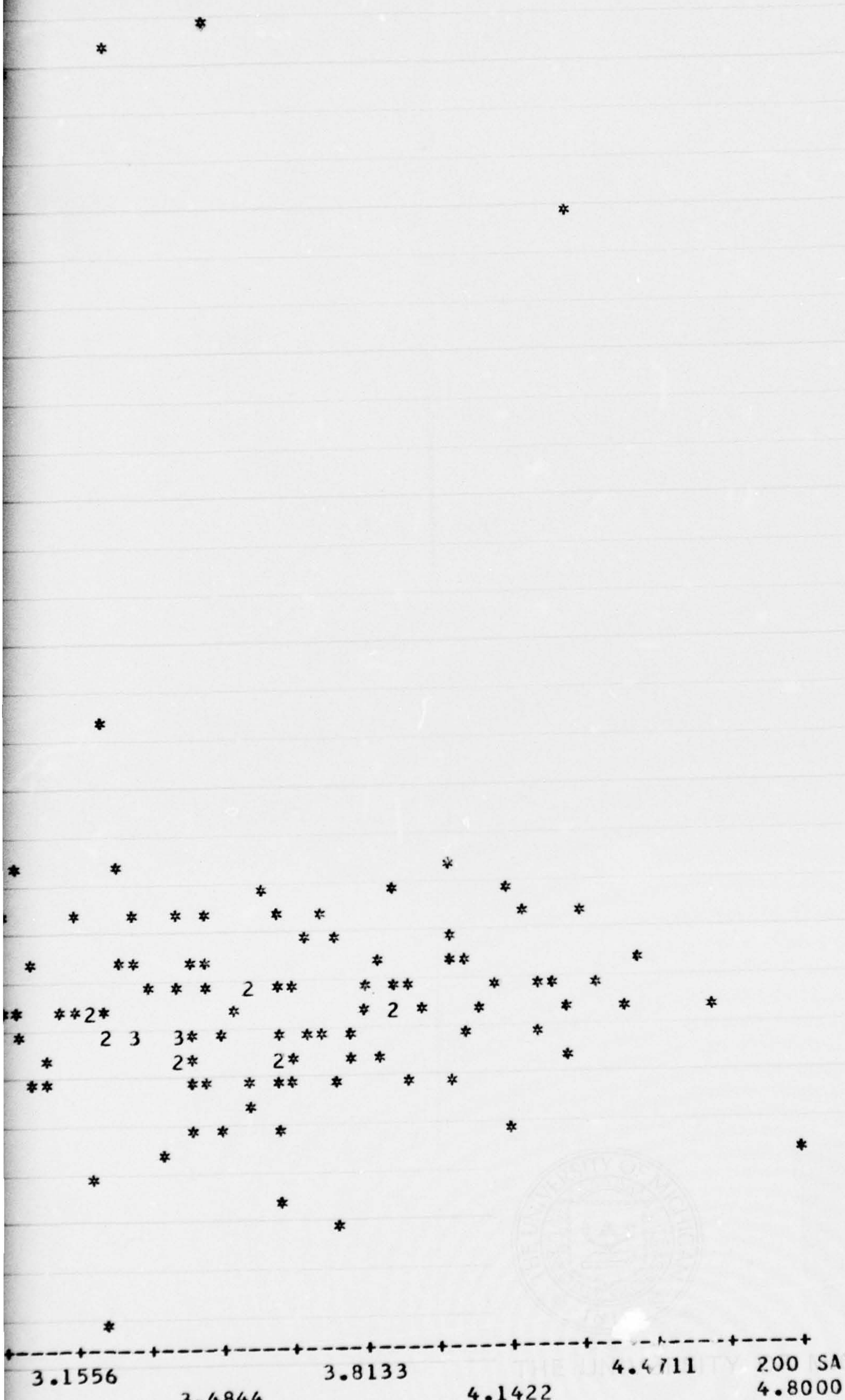

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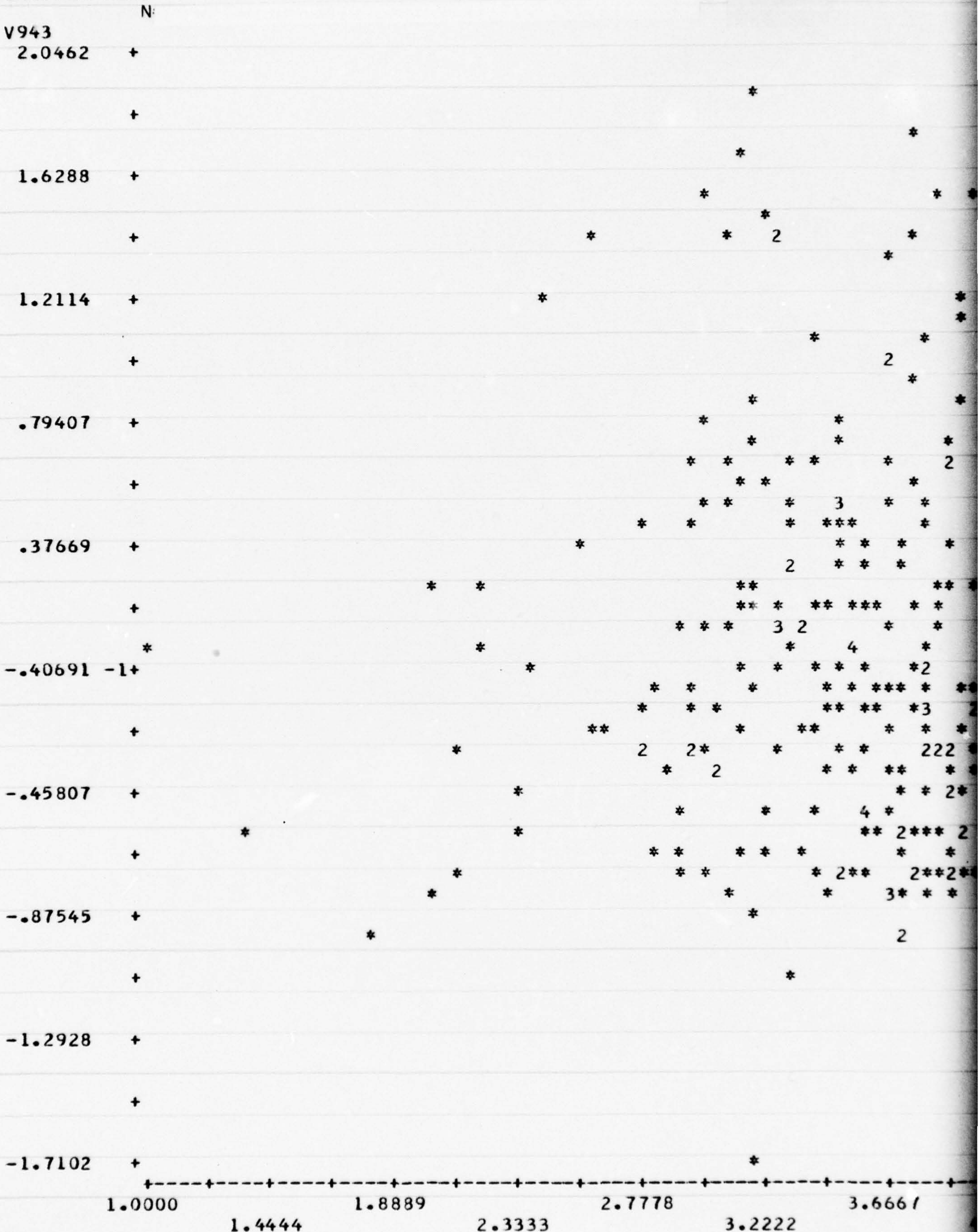

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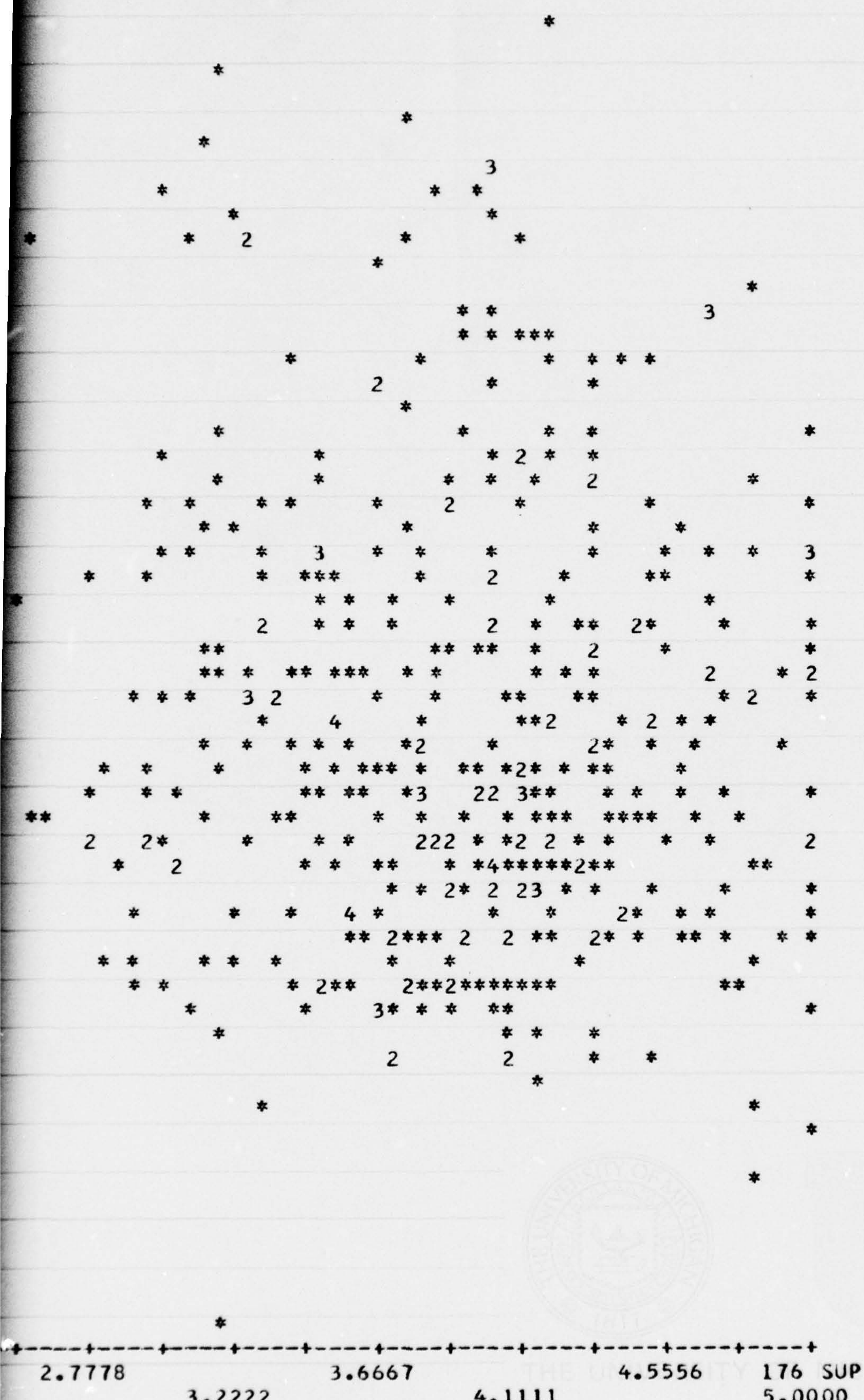

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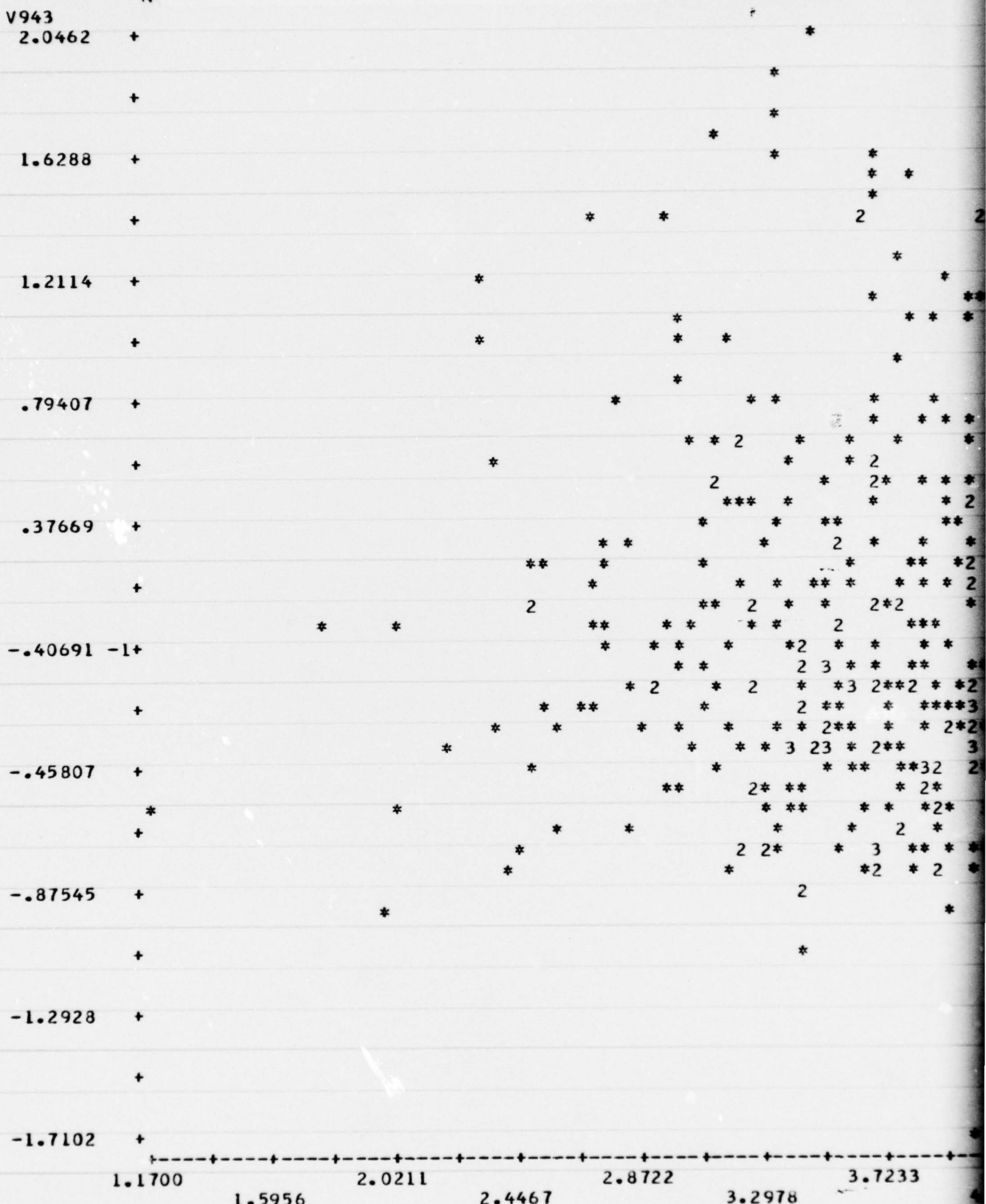

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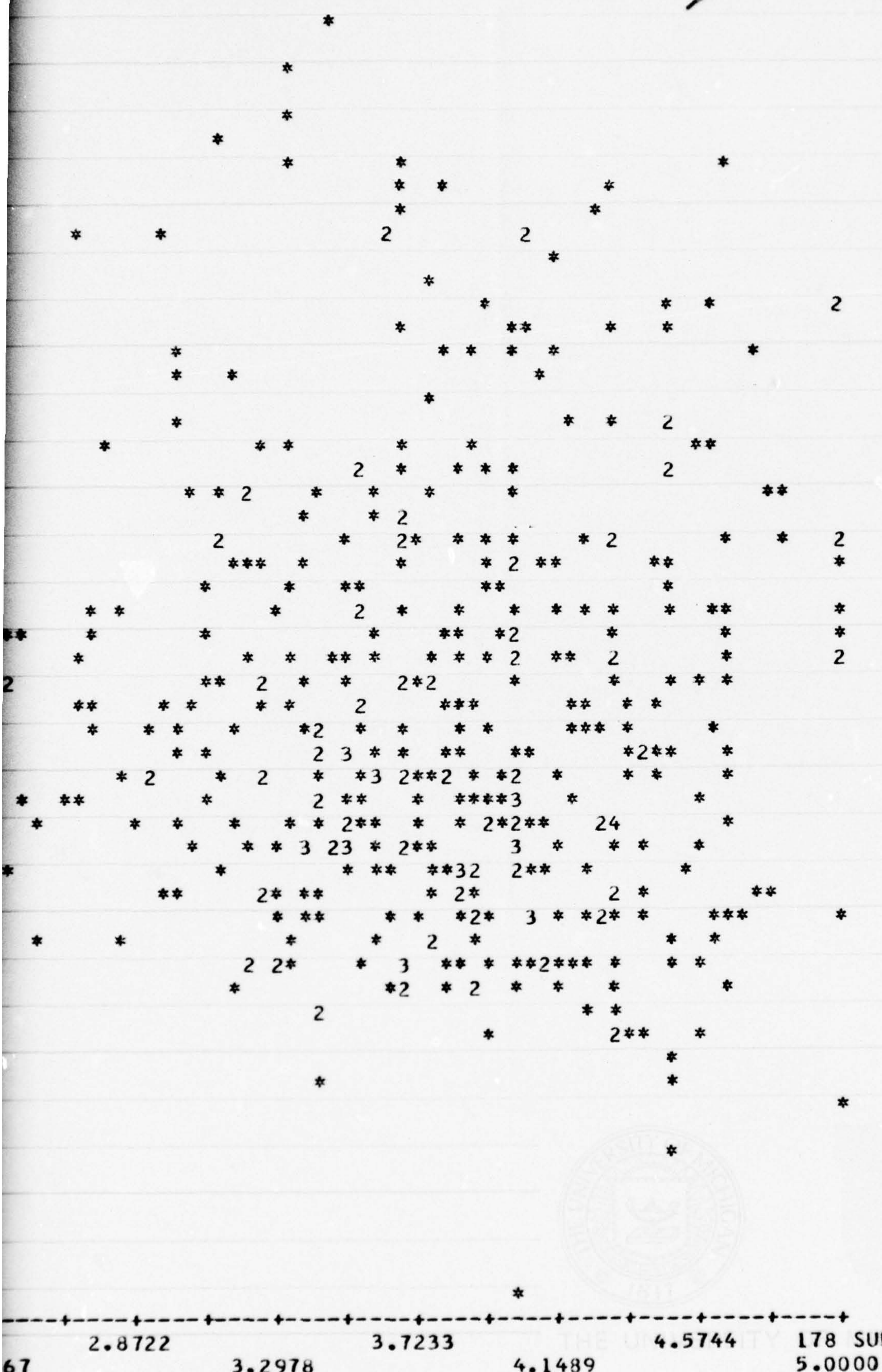

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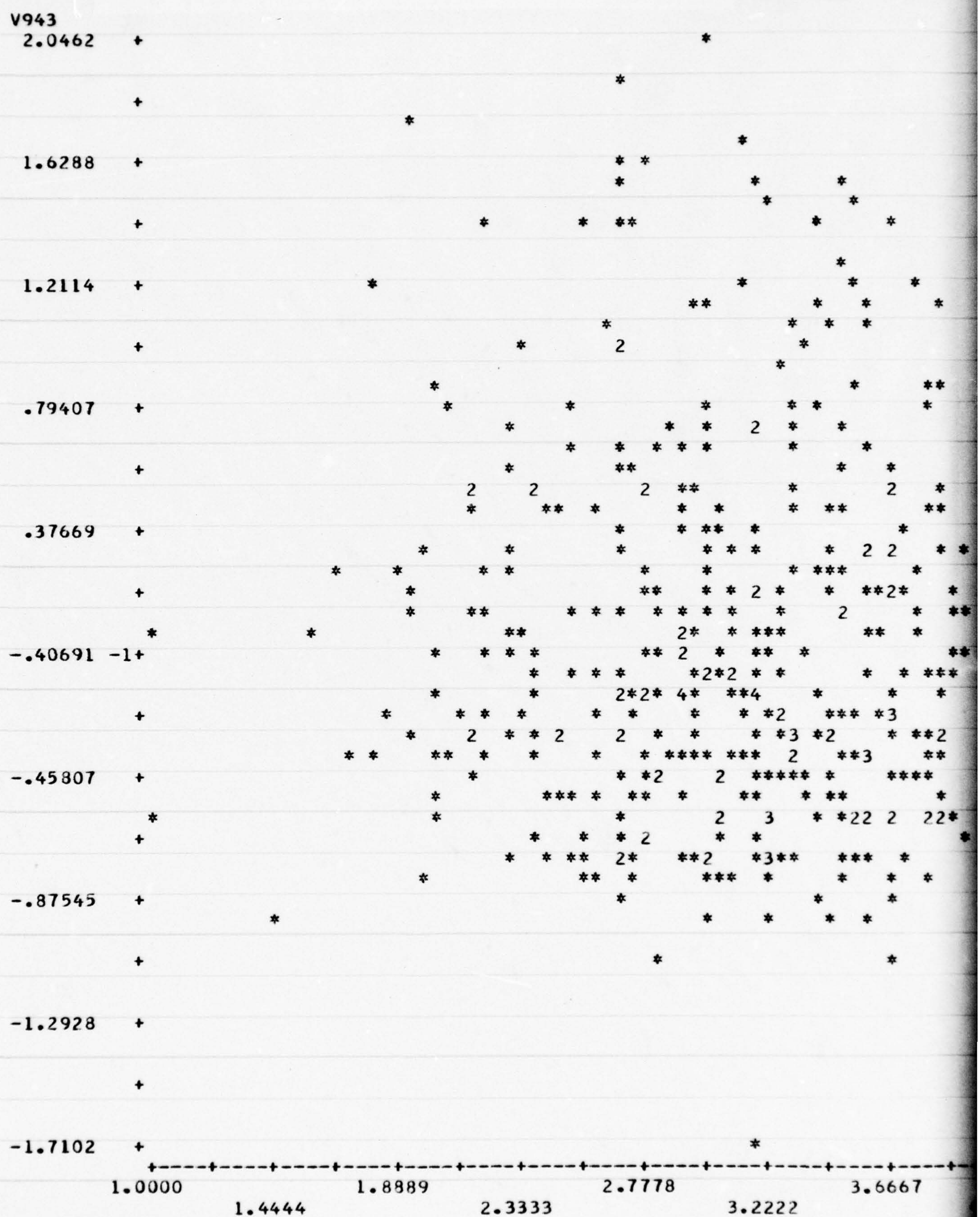

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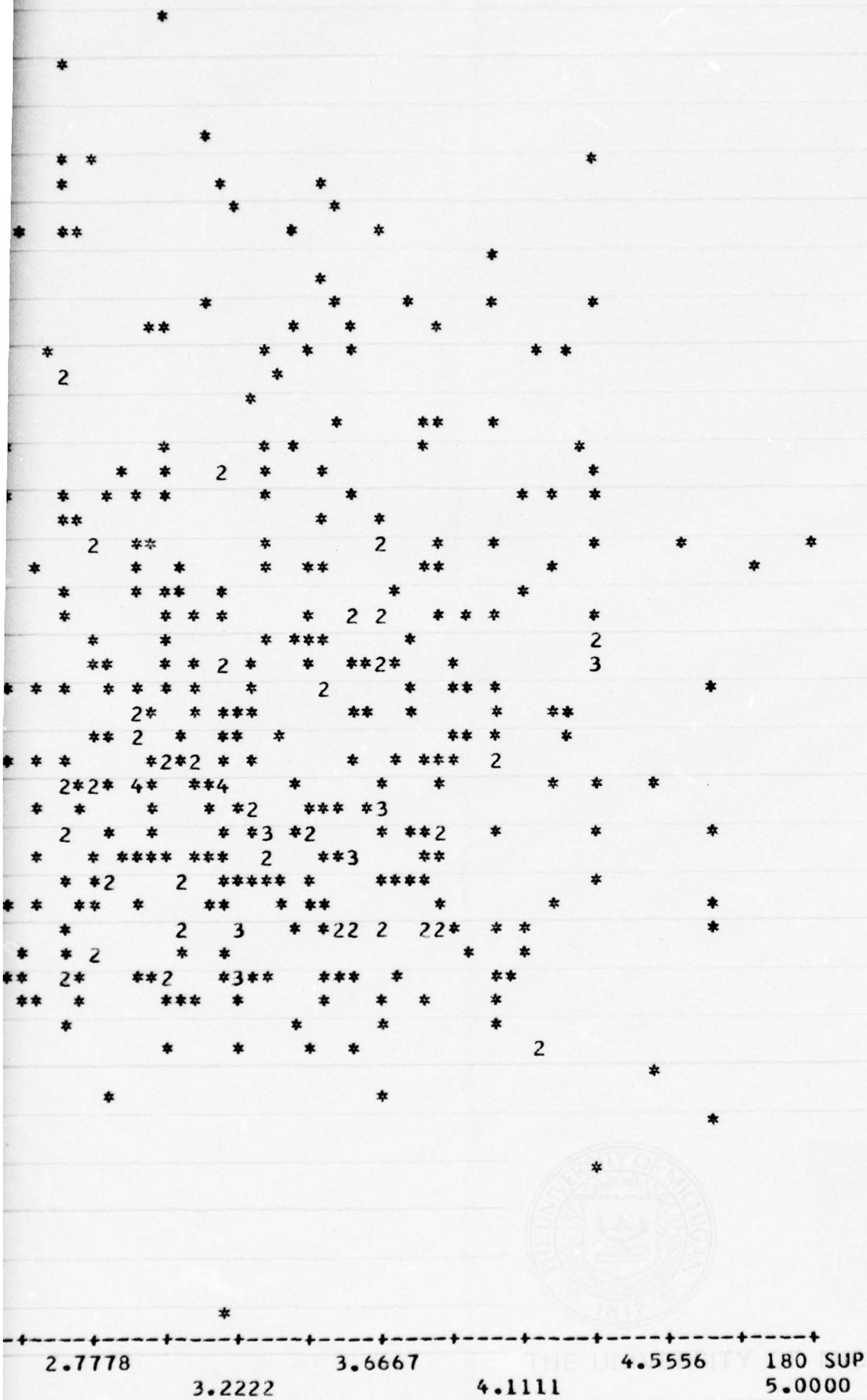

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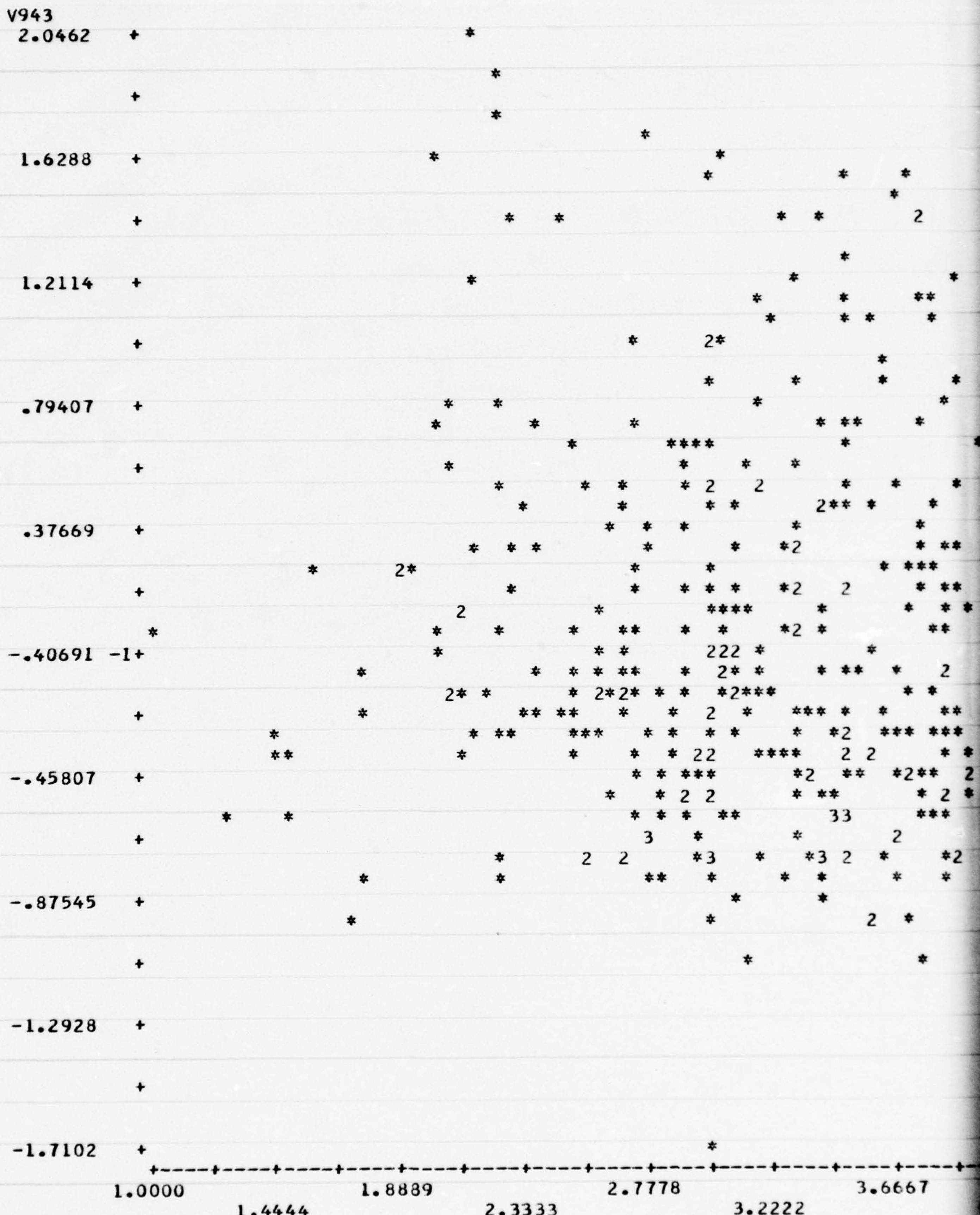

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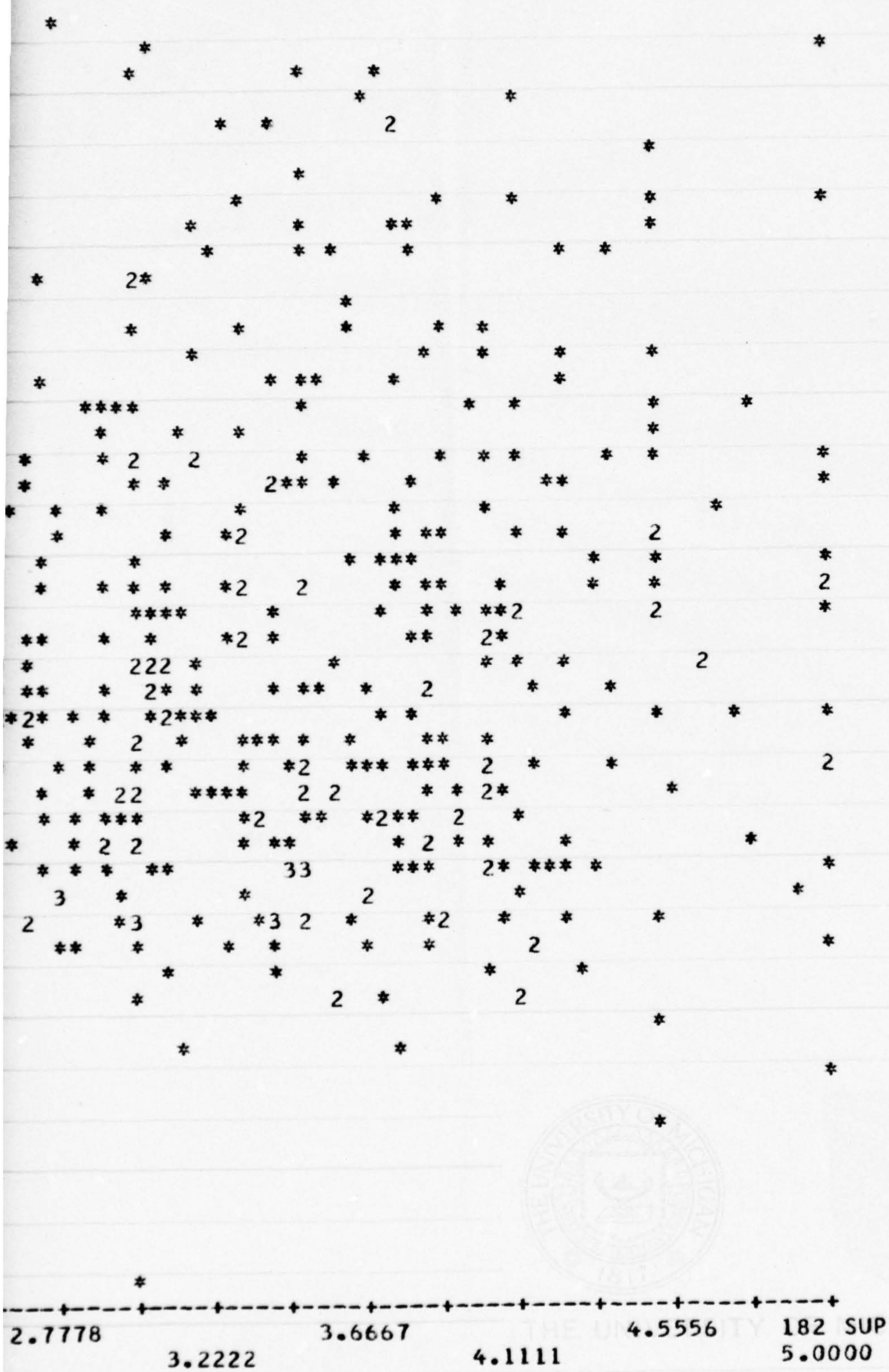

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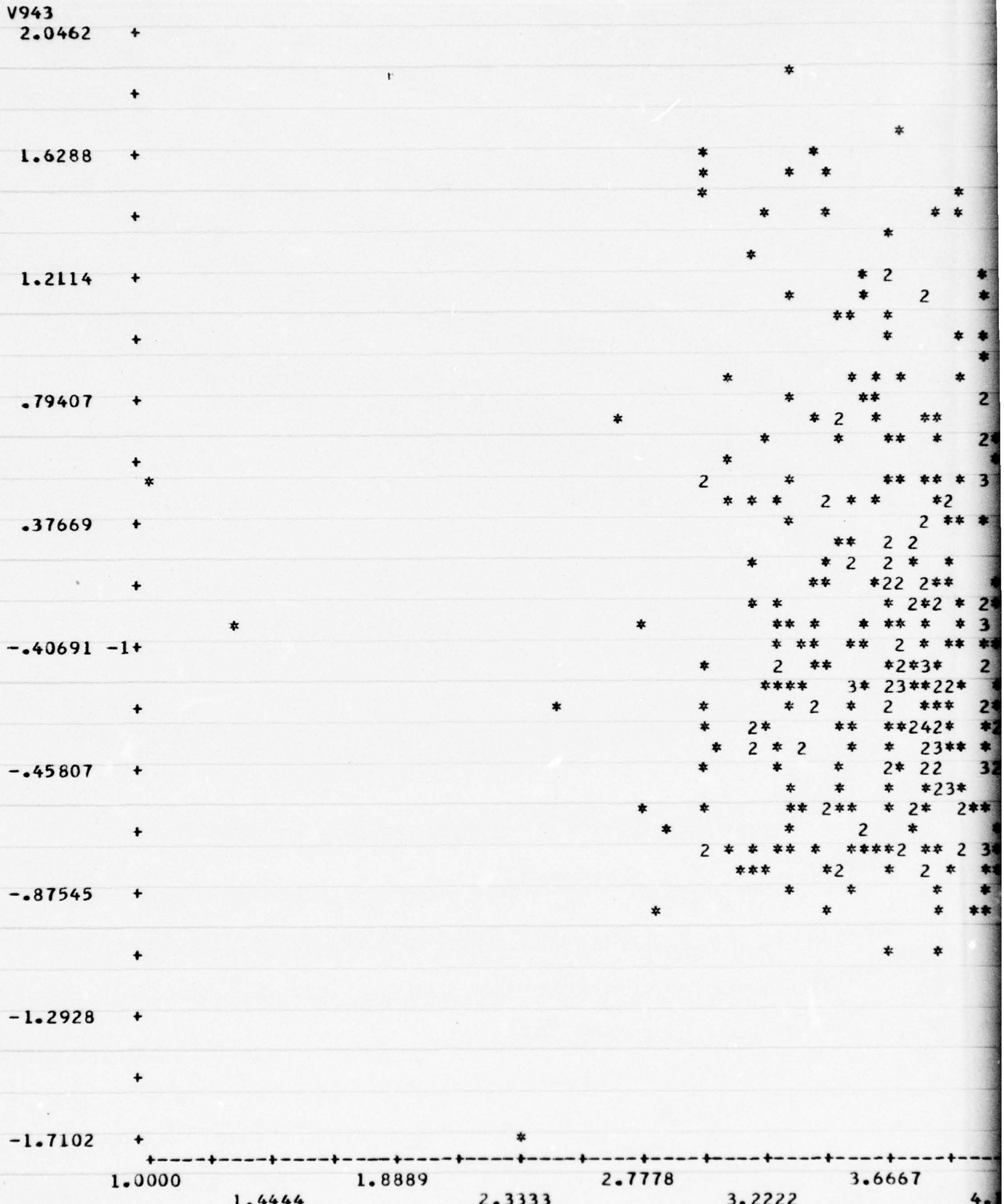

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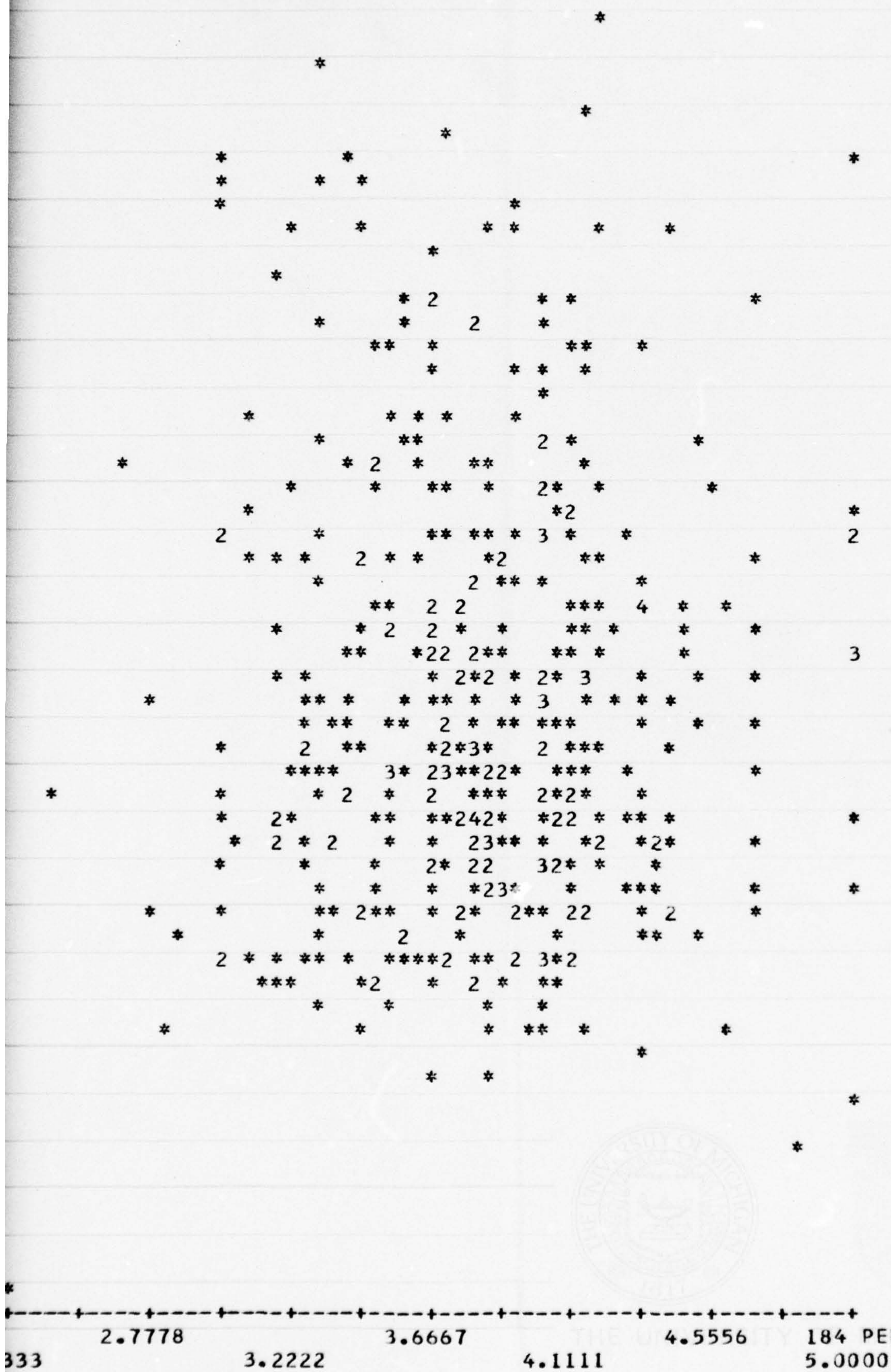

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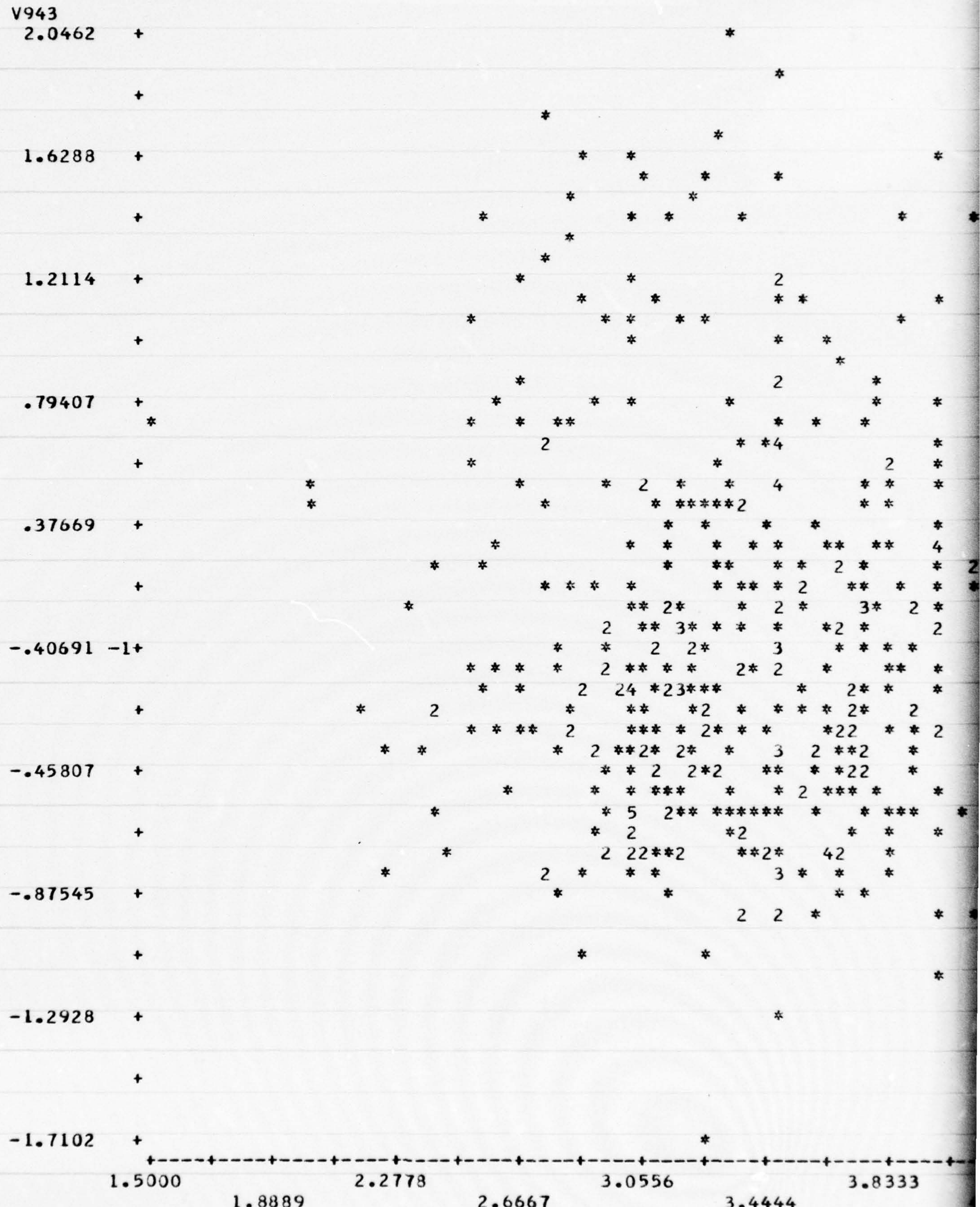

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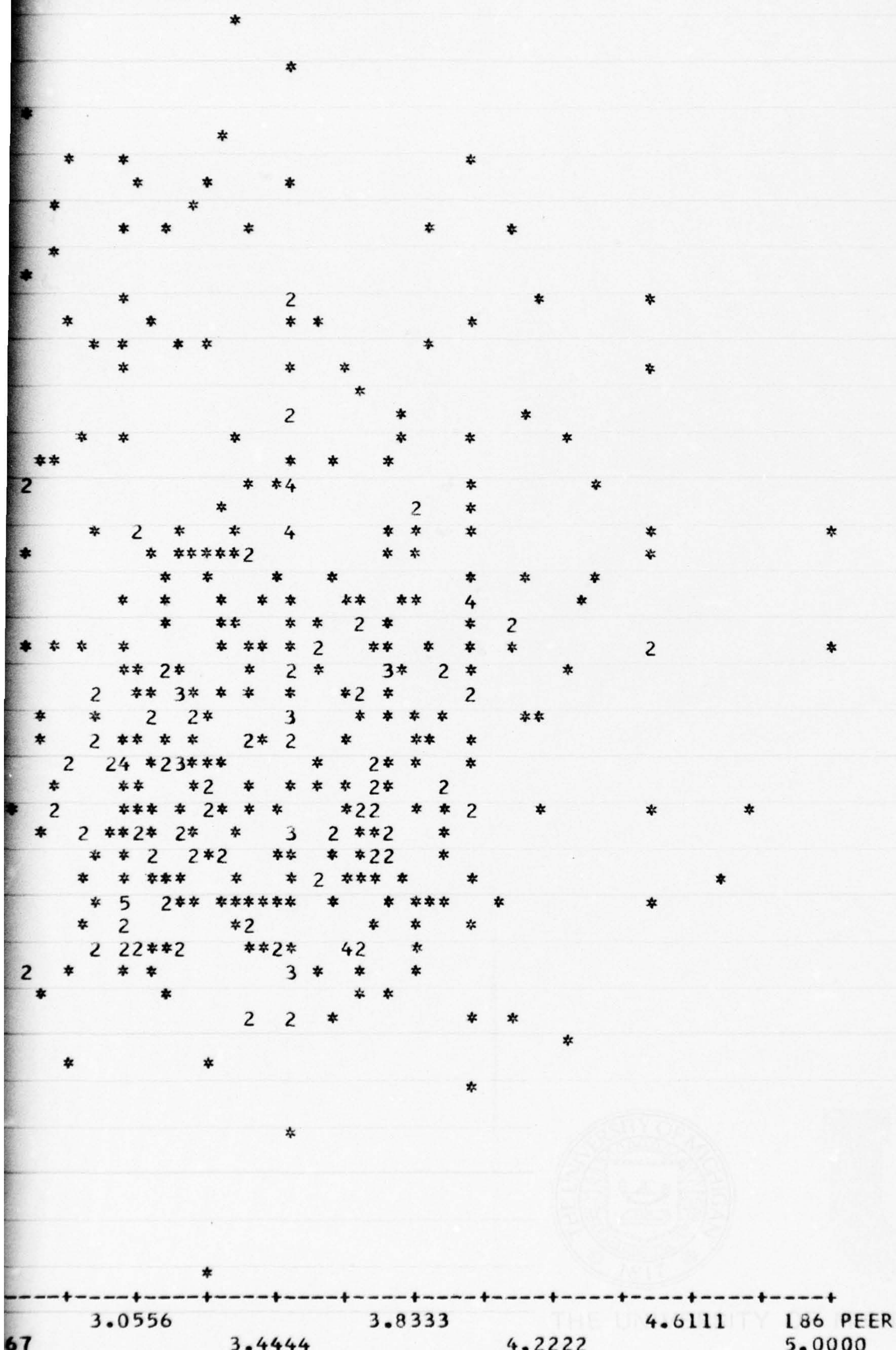

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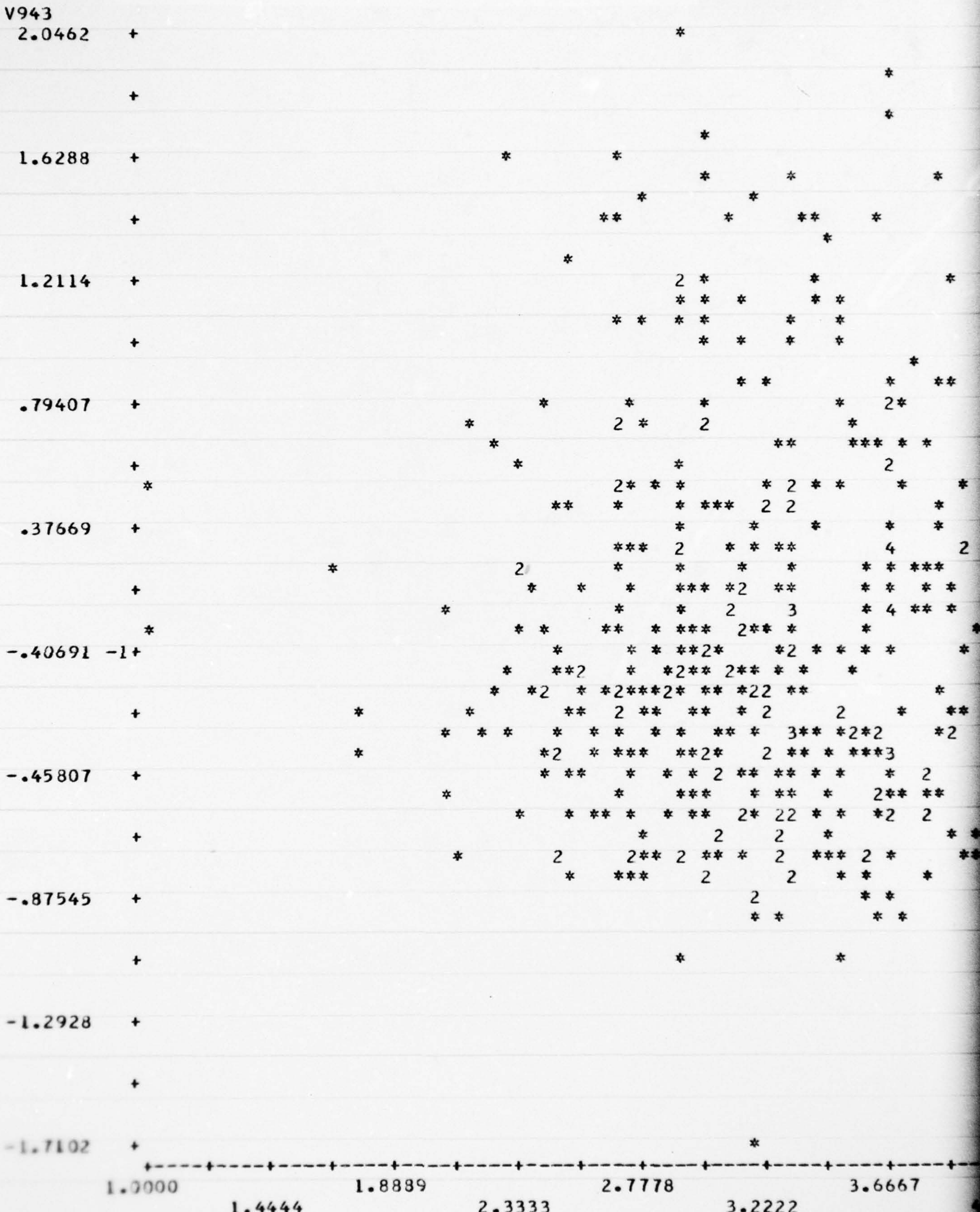

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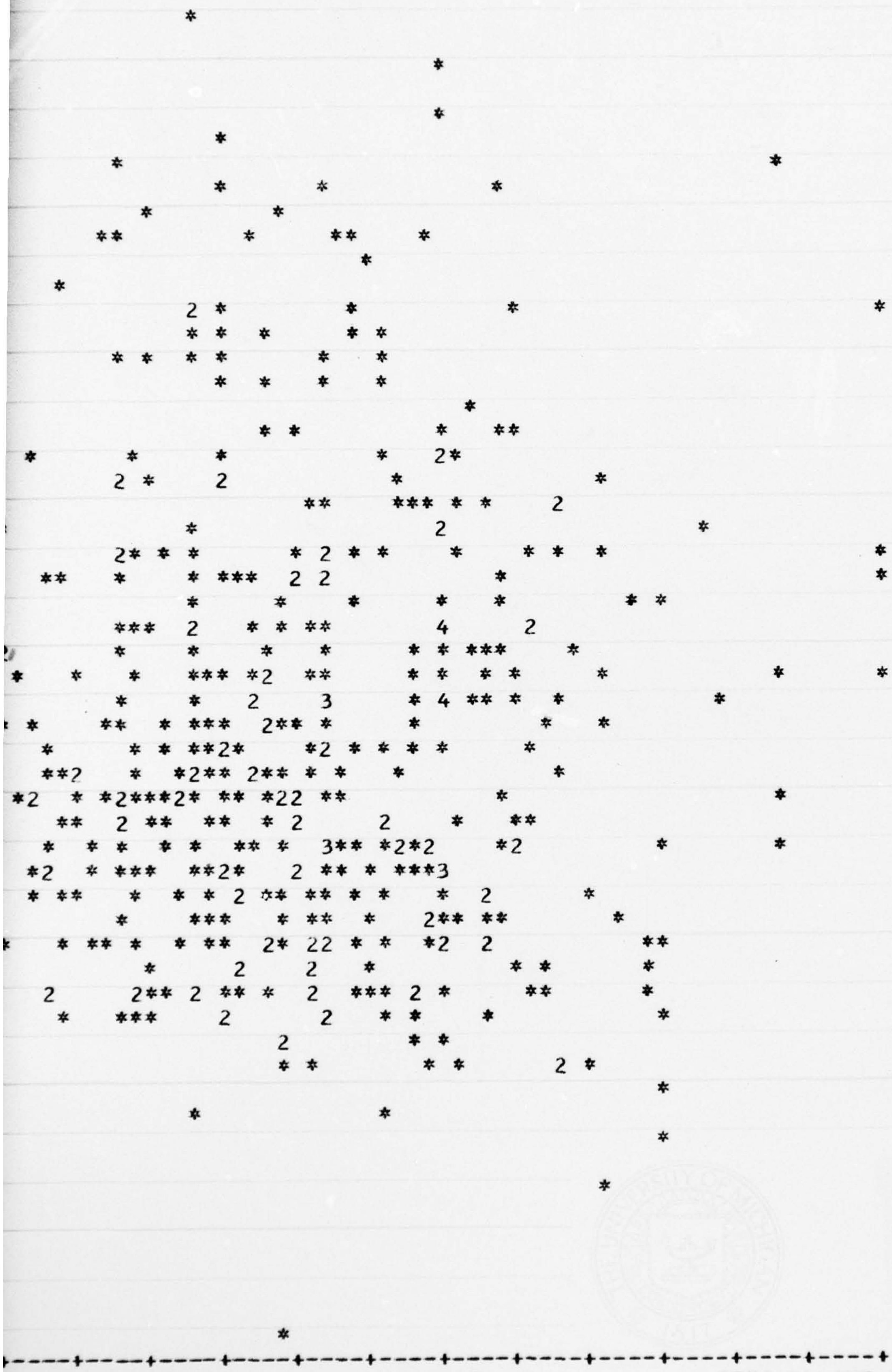

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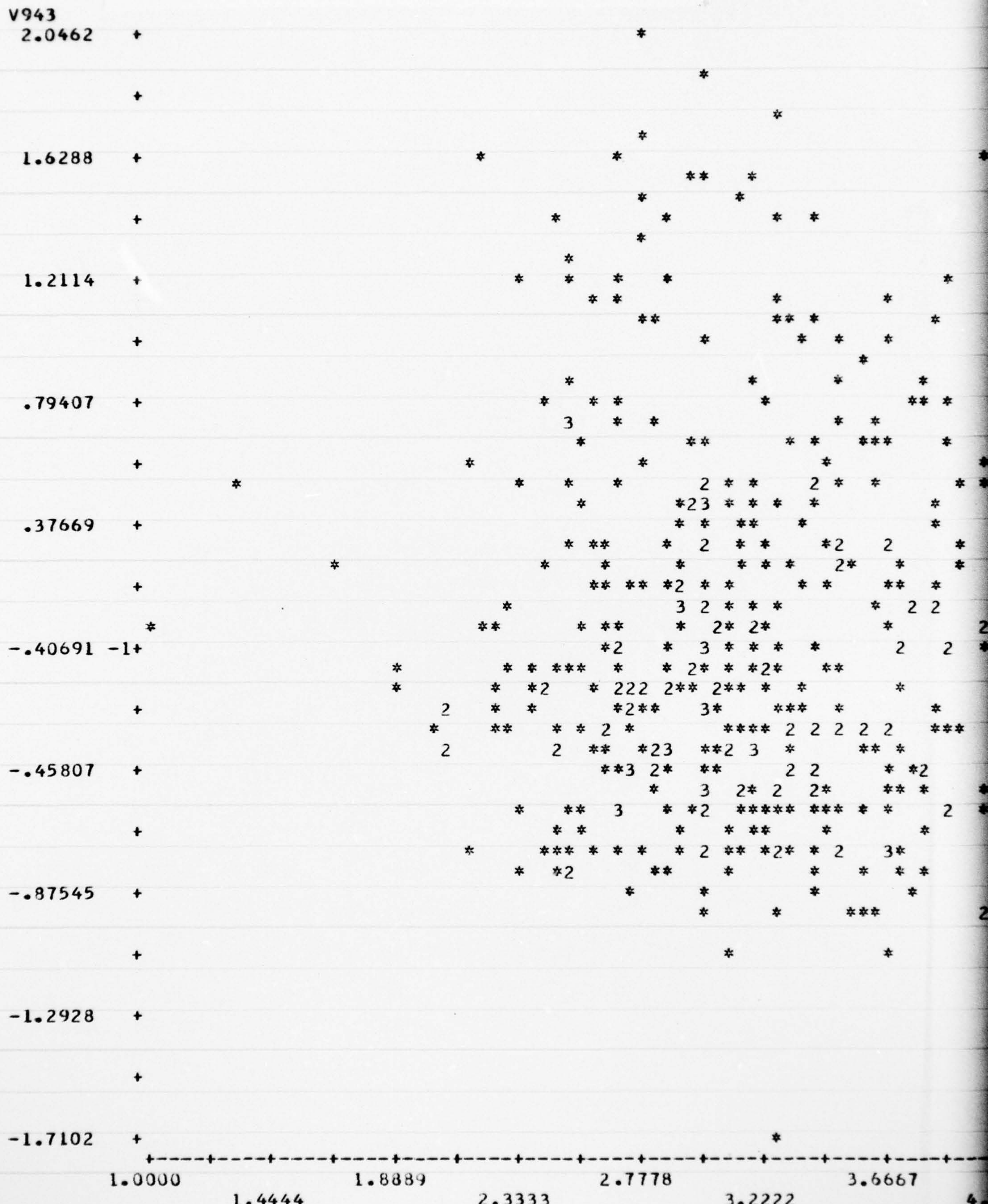

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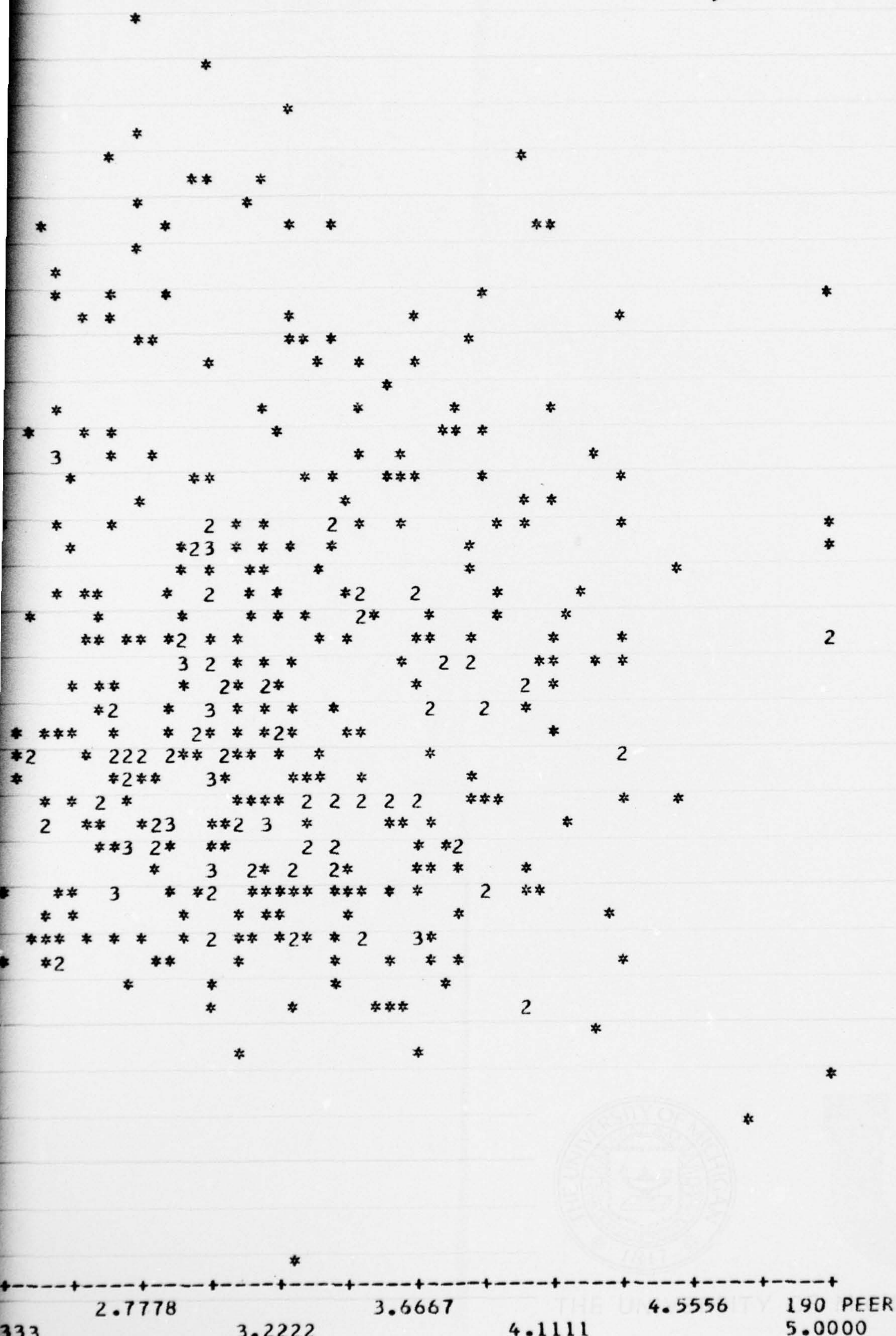

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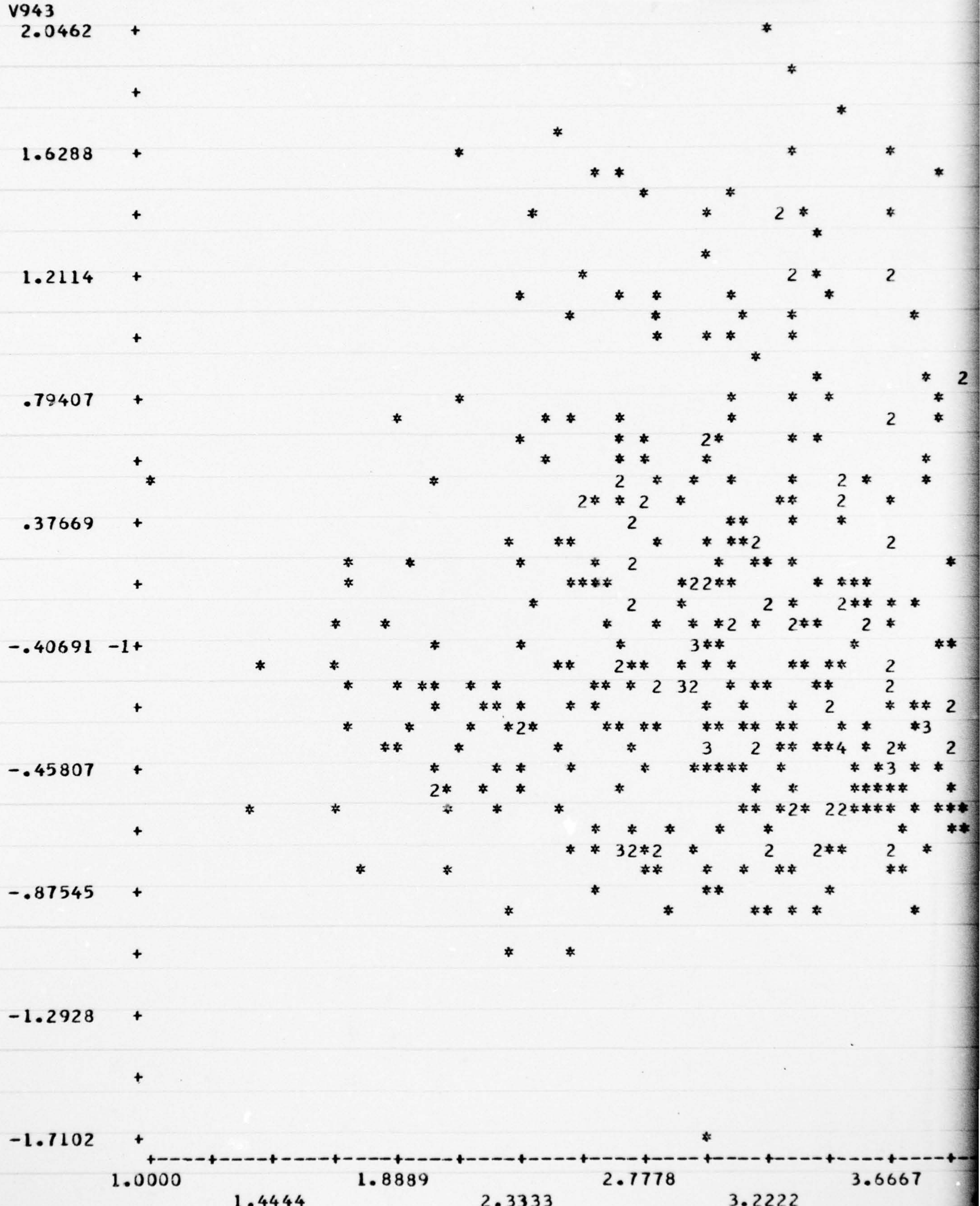

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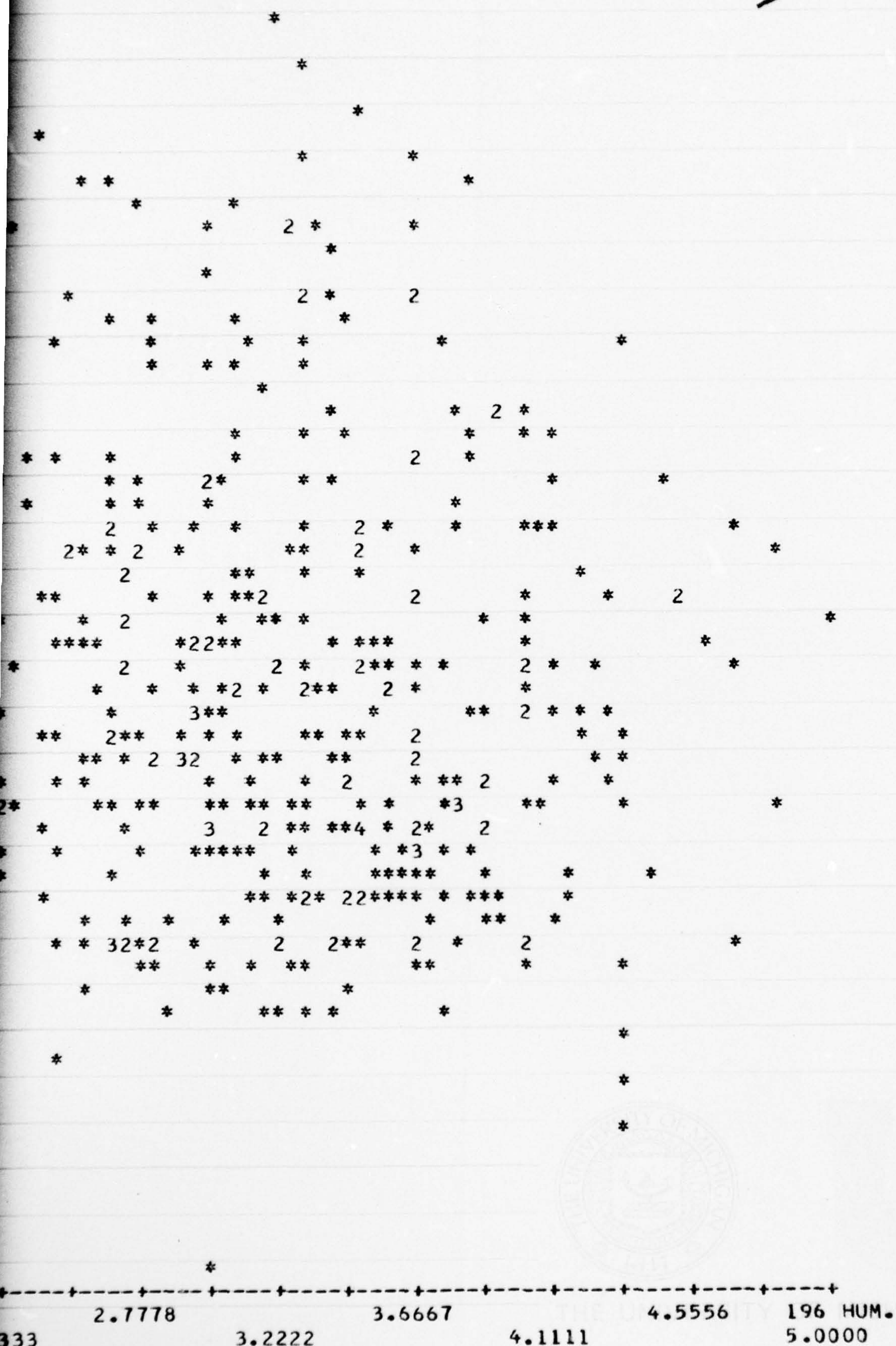

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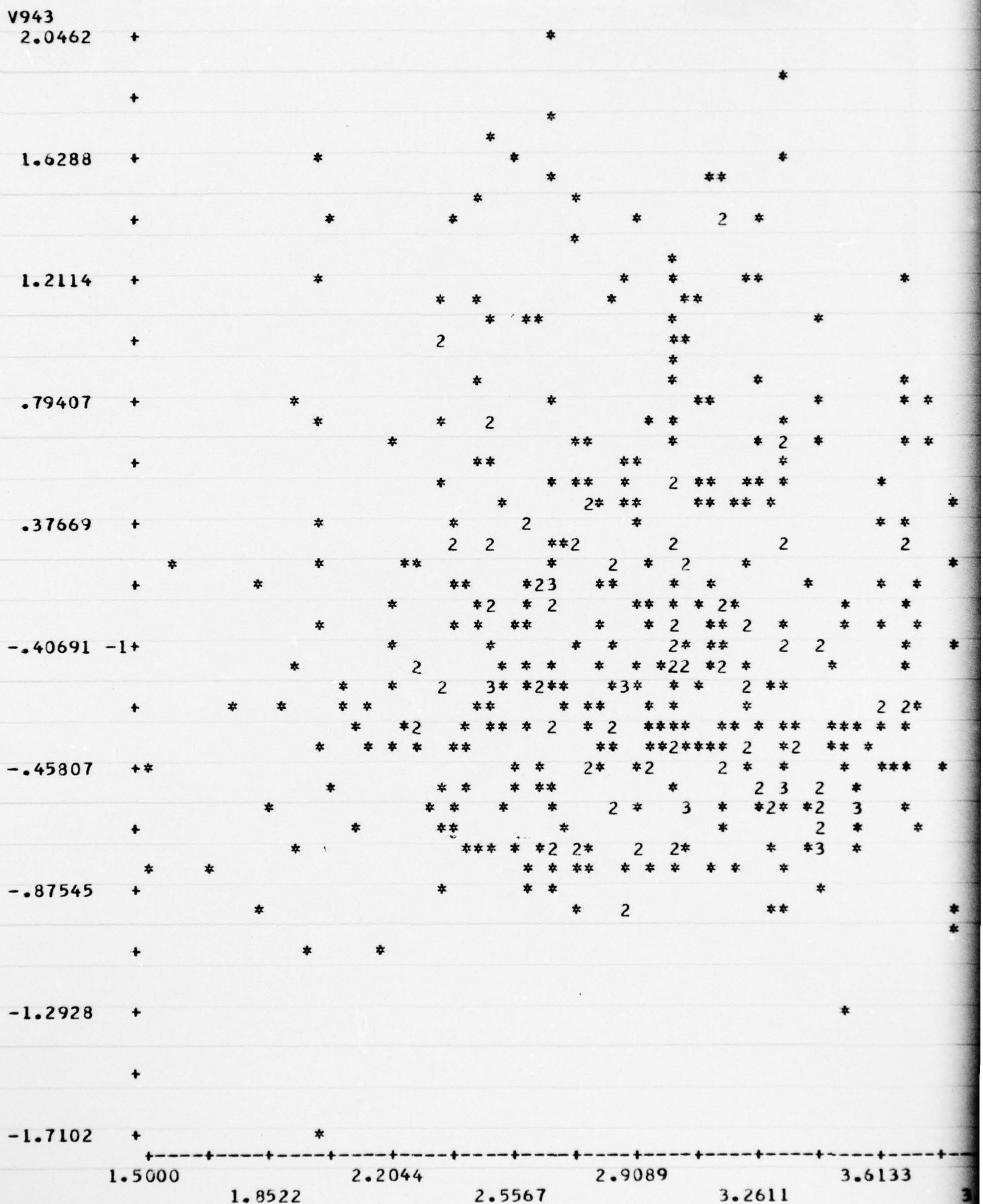

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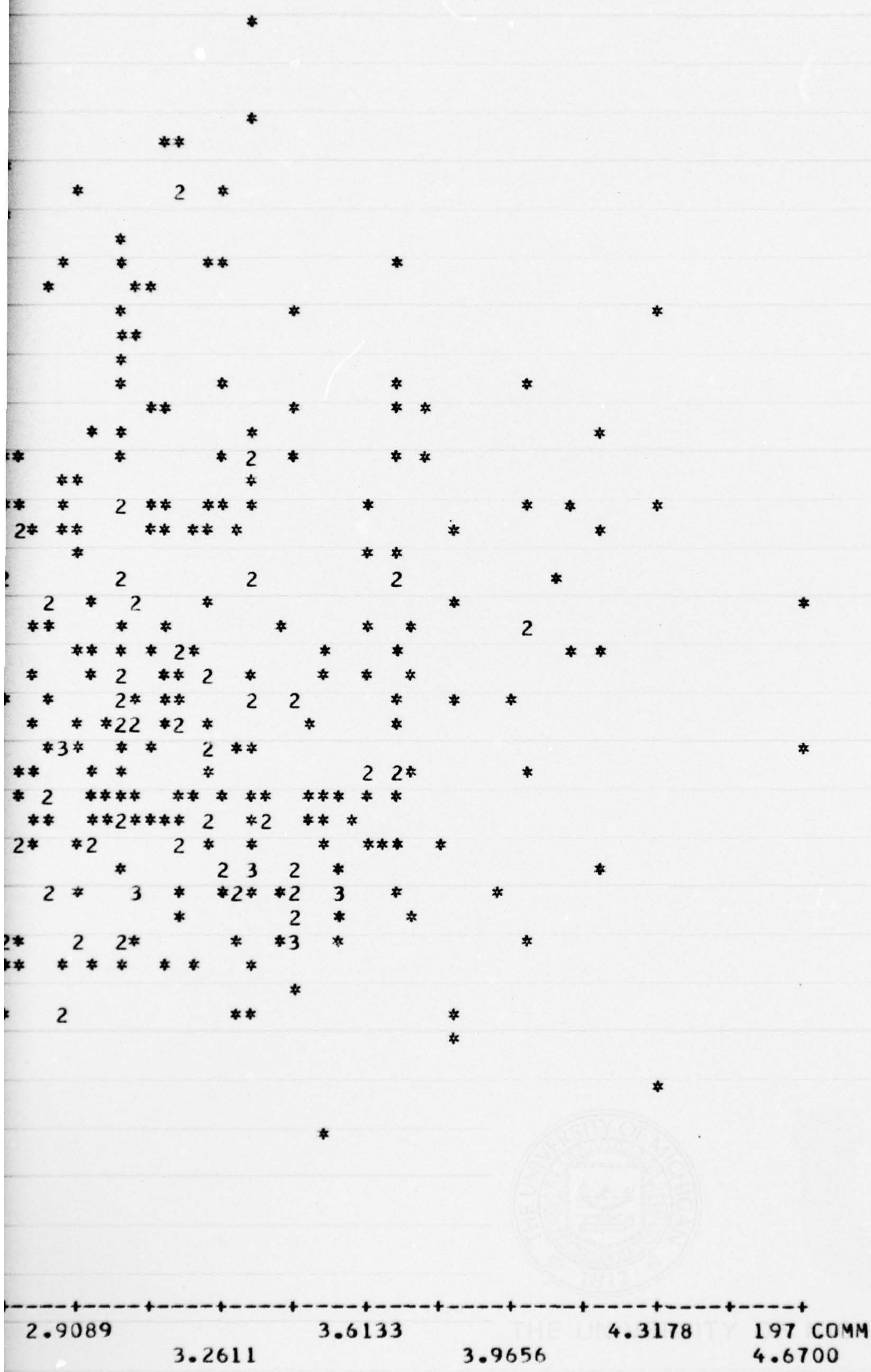

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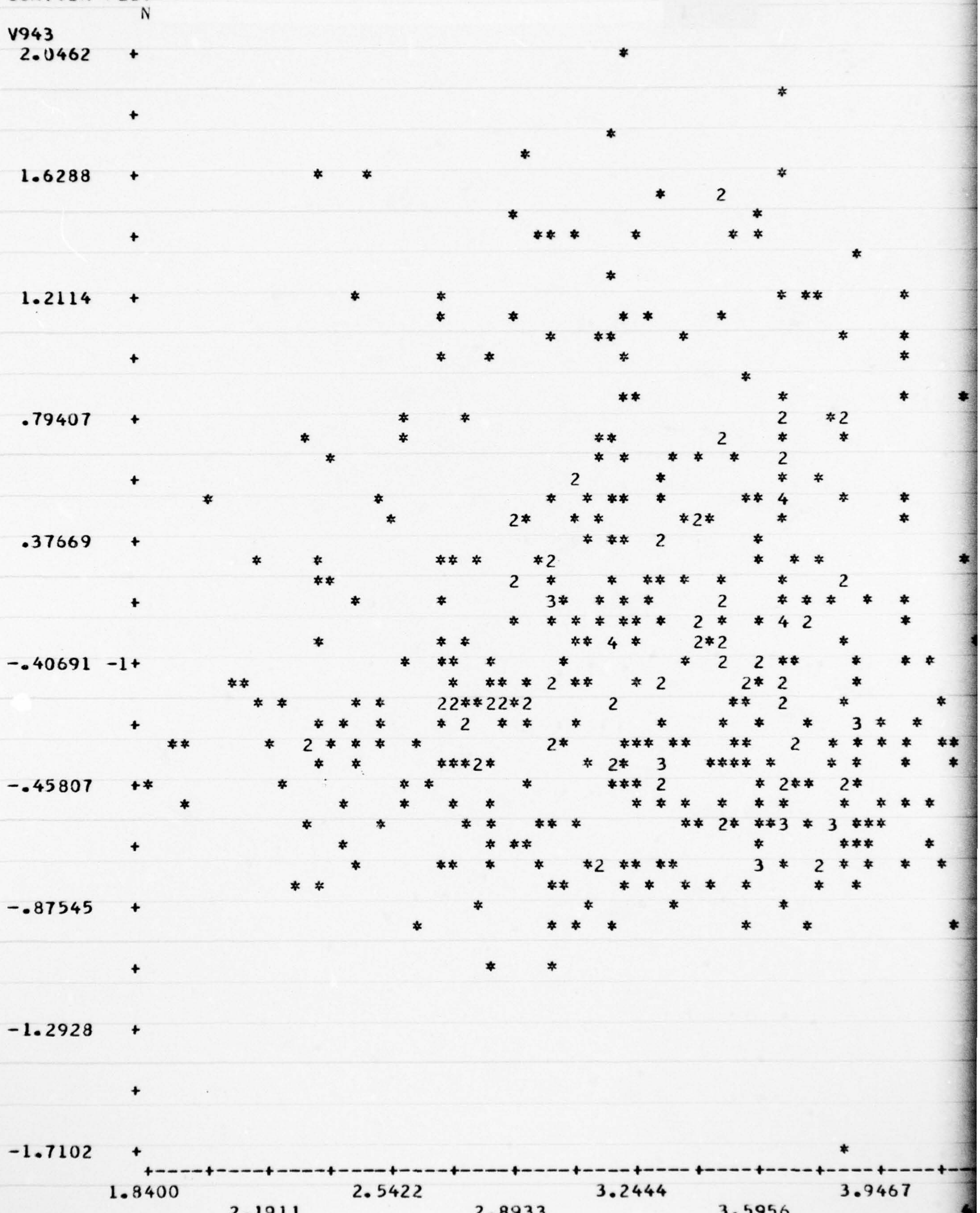

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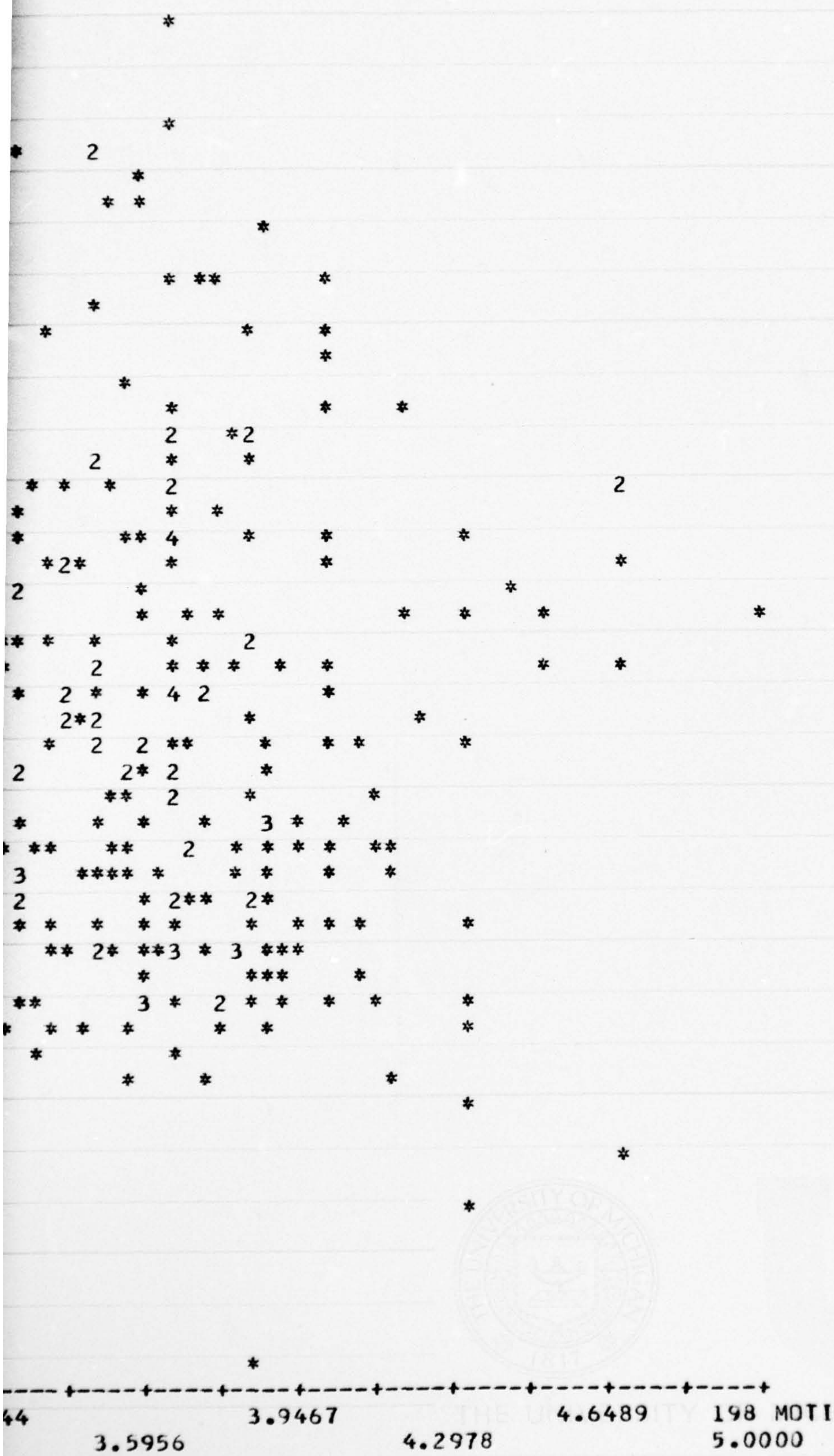

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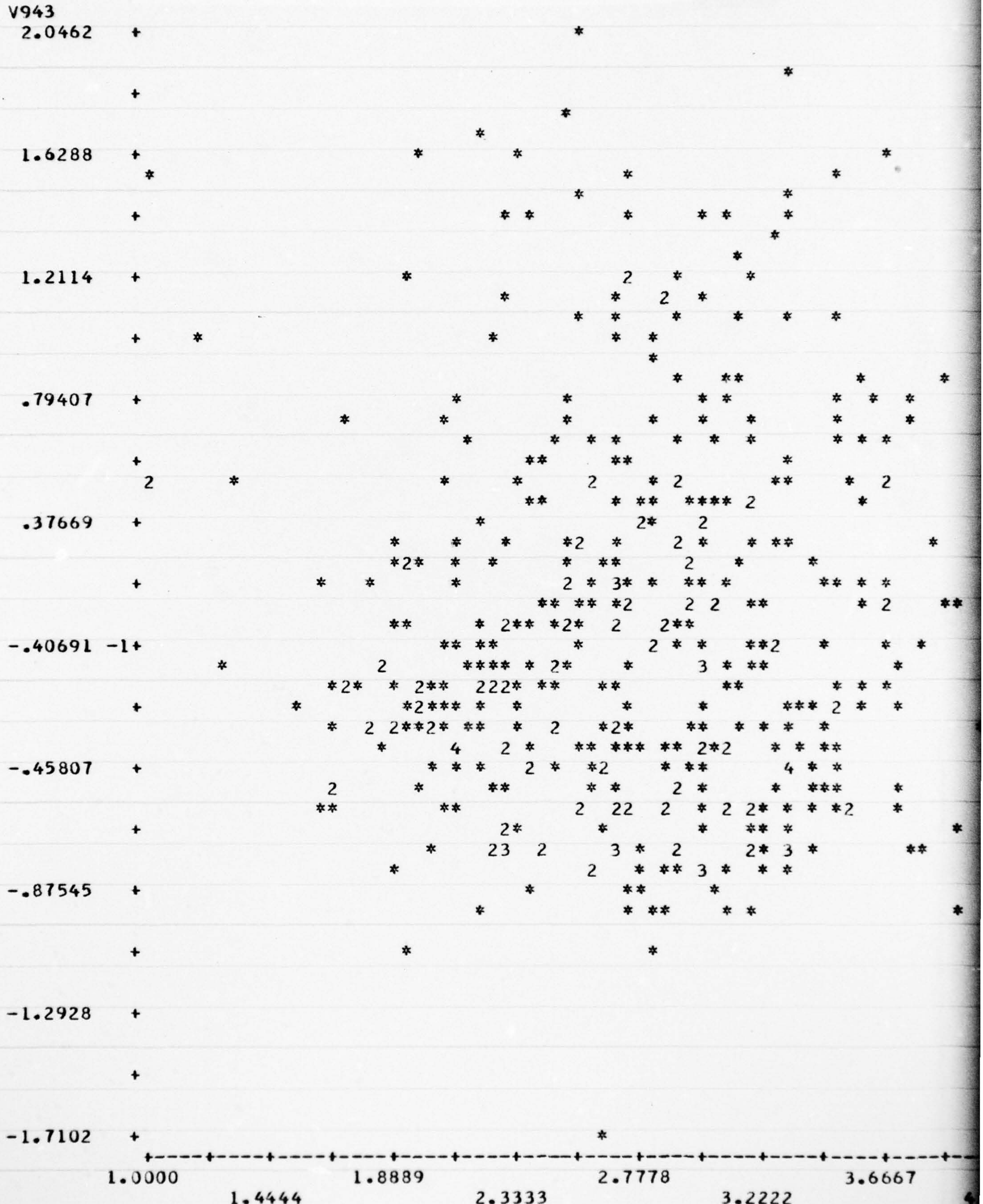

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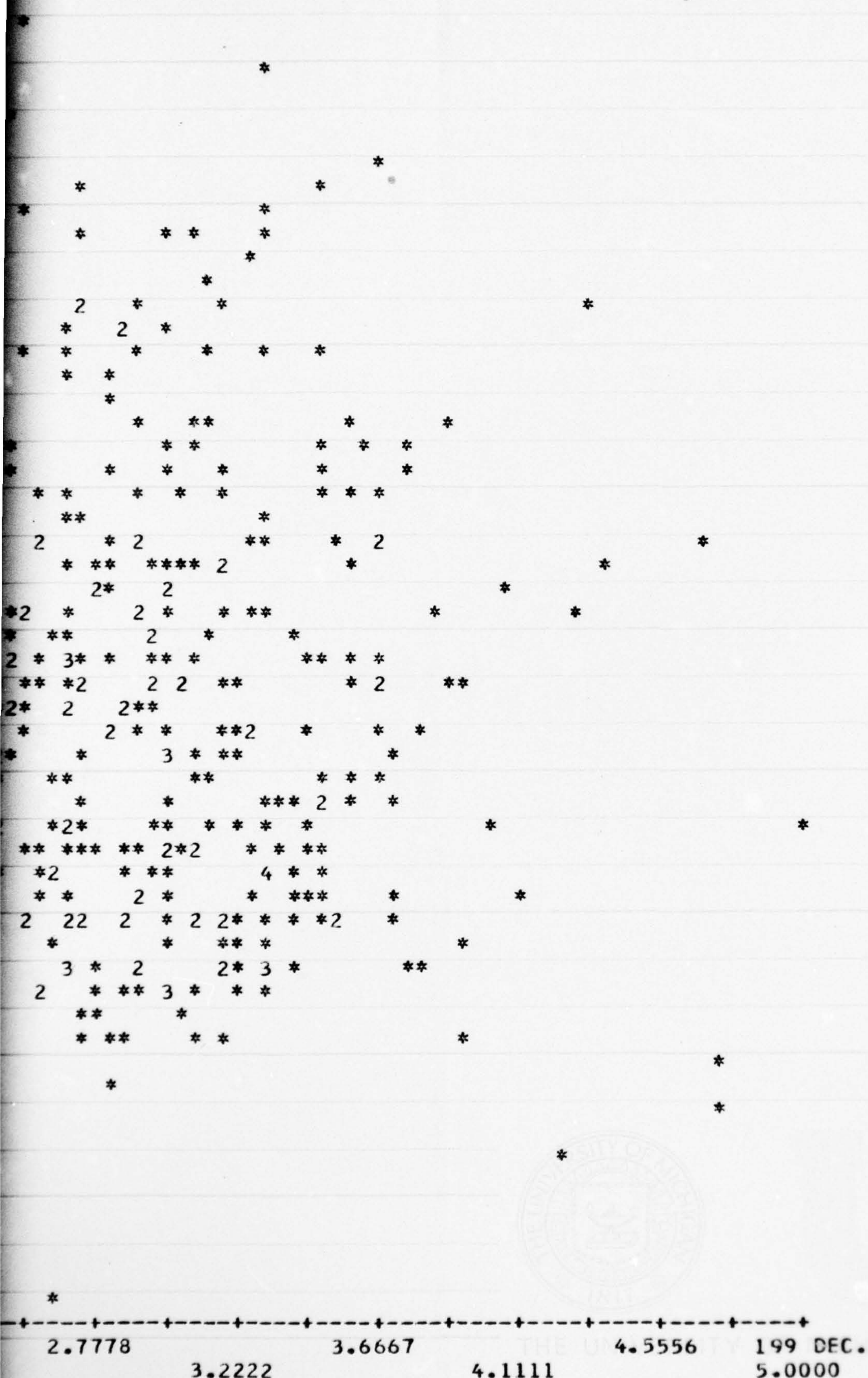

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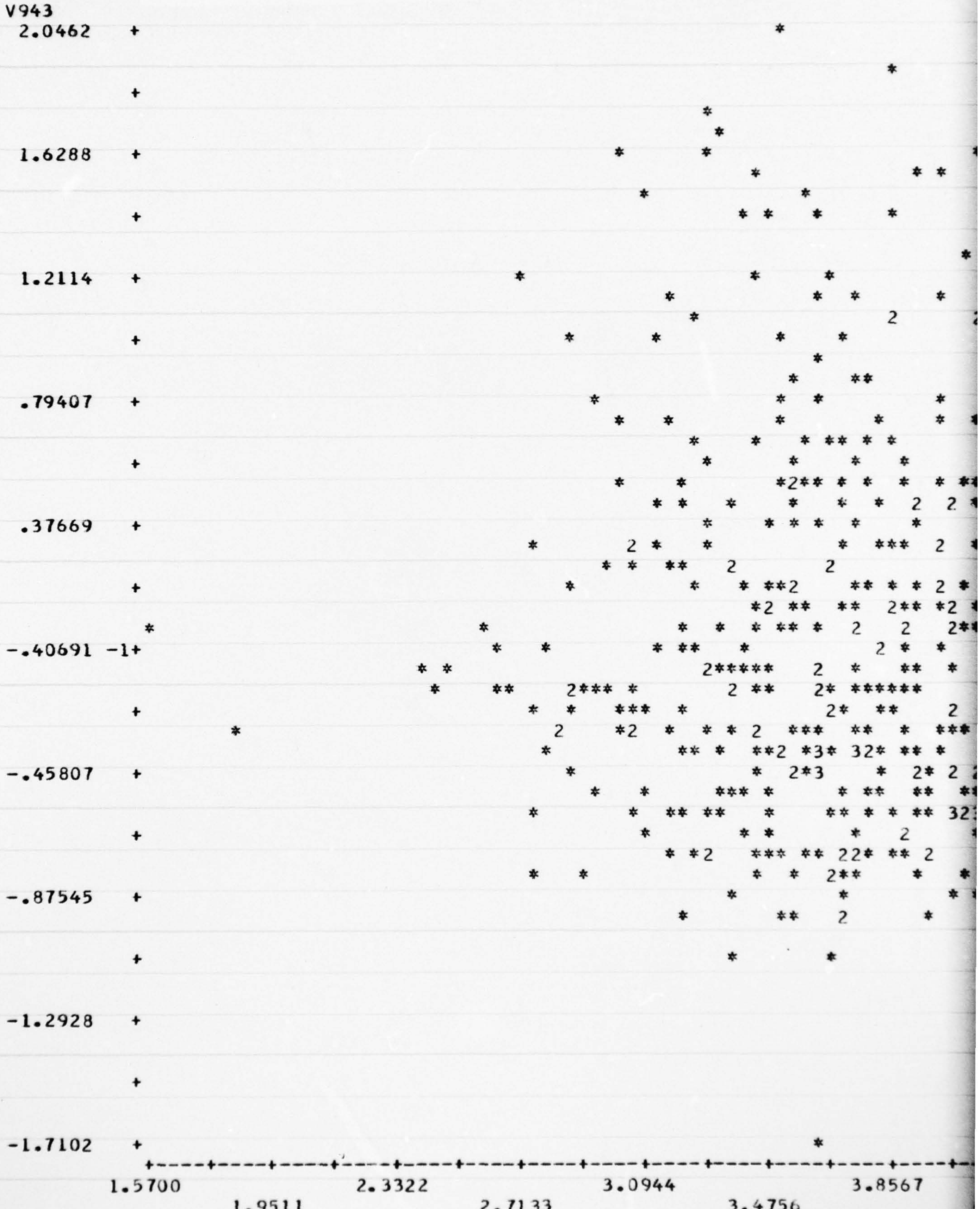

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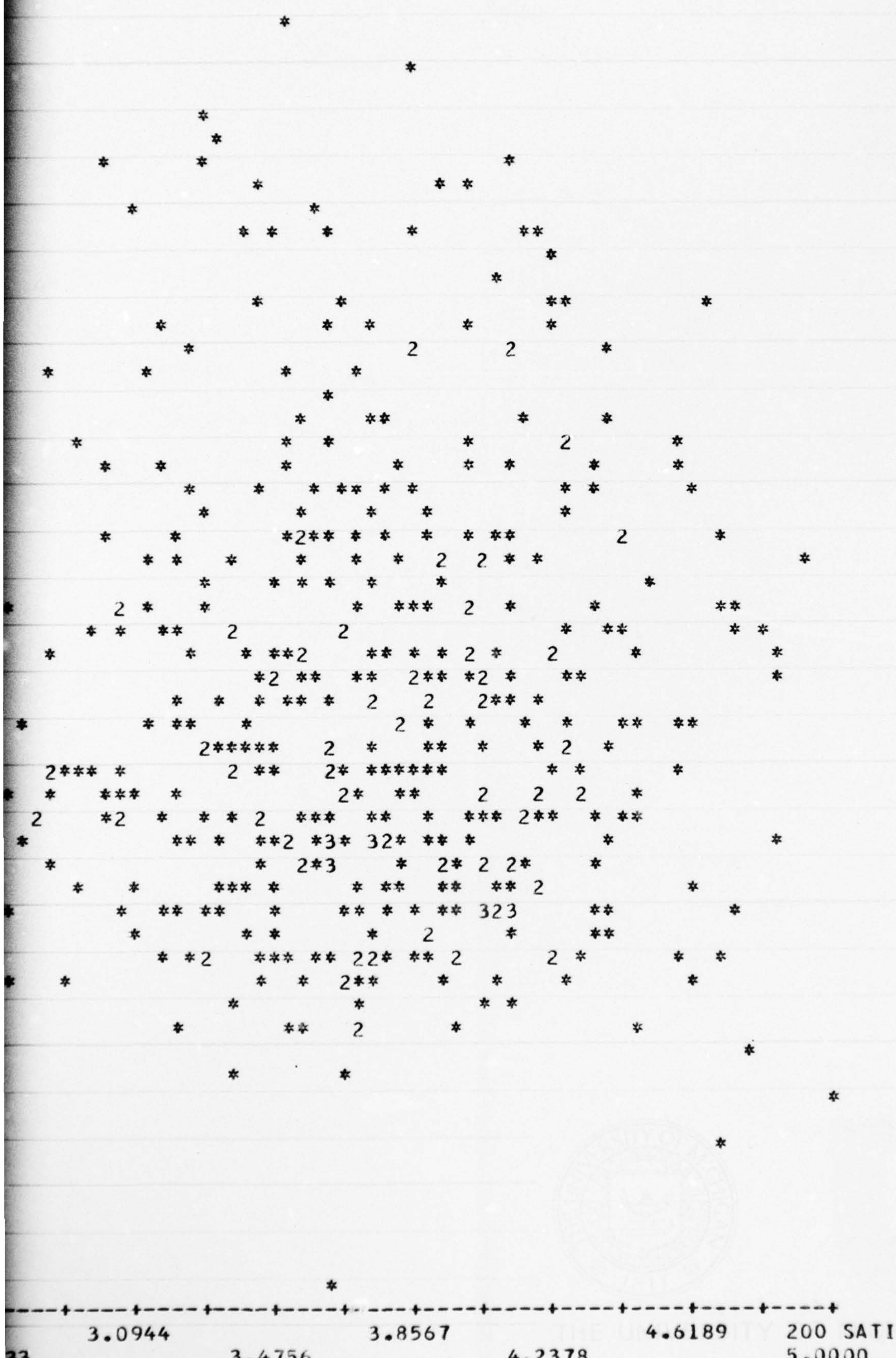

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FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH T--ETC(U)
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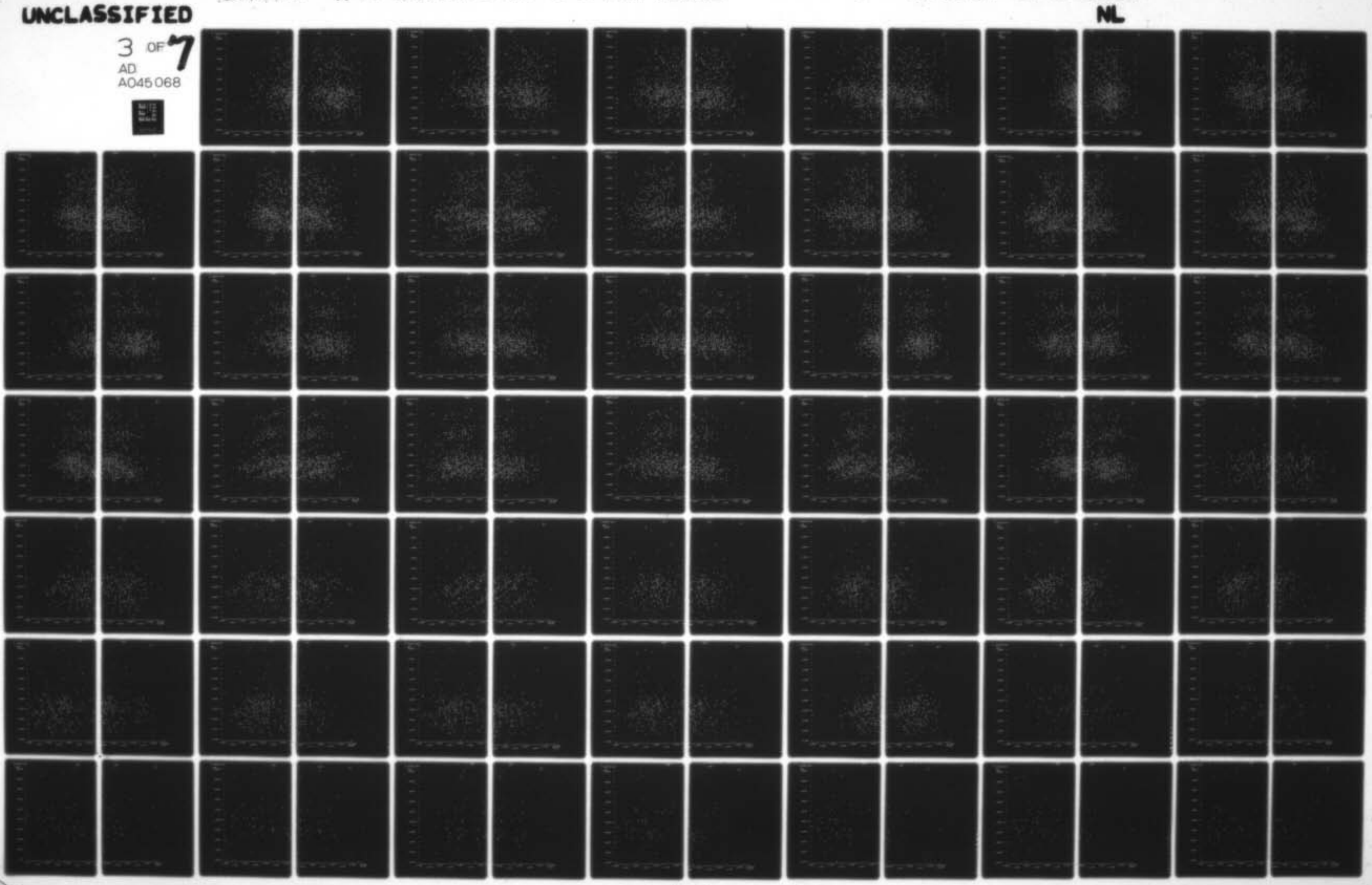

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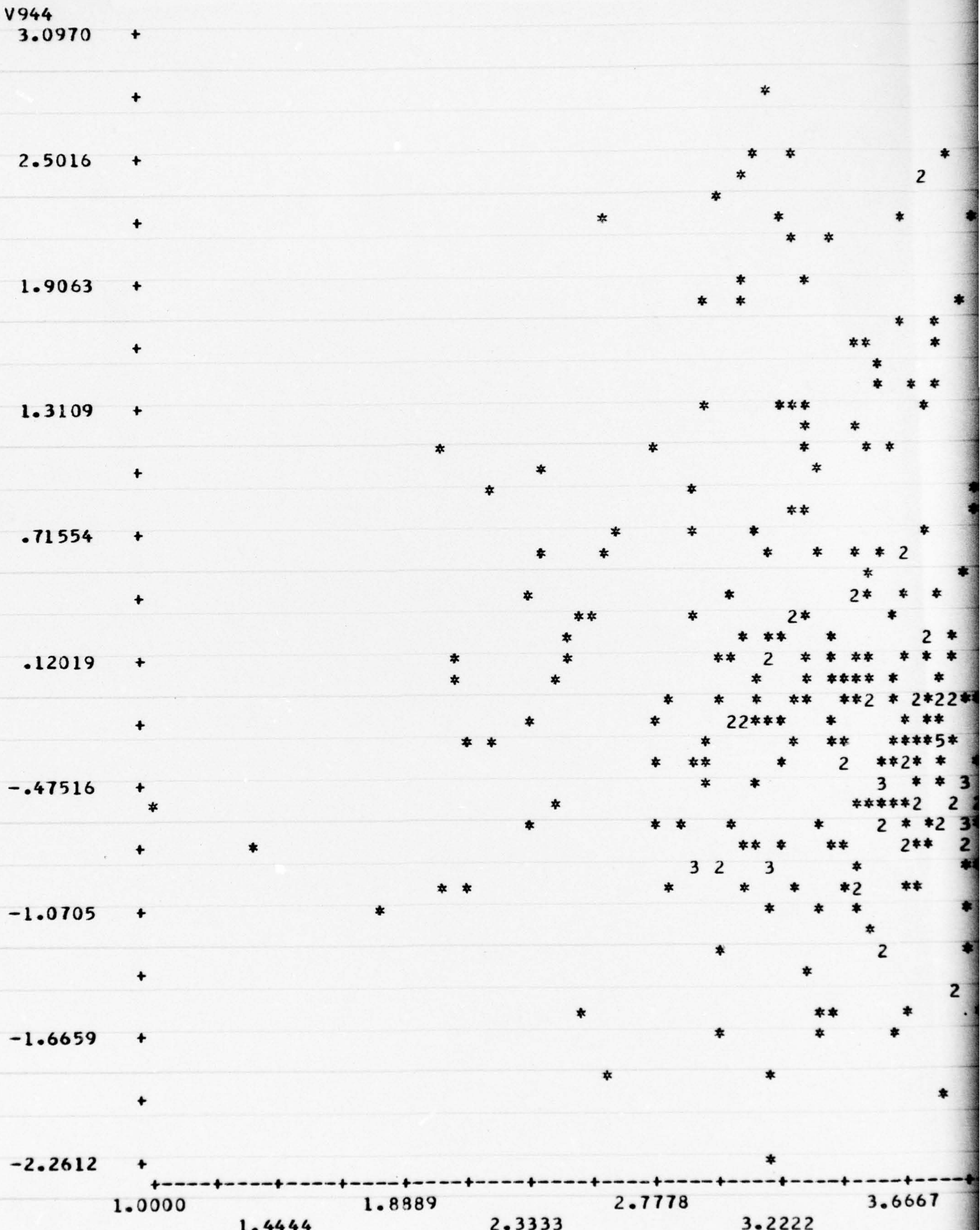

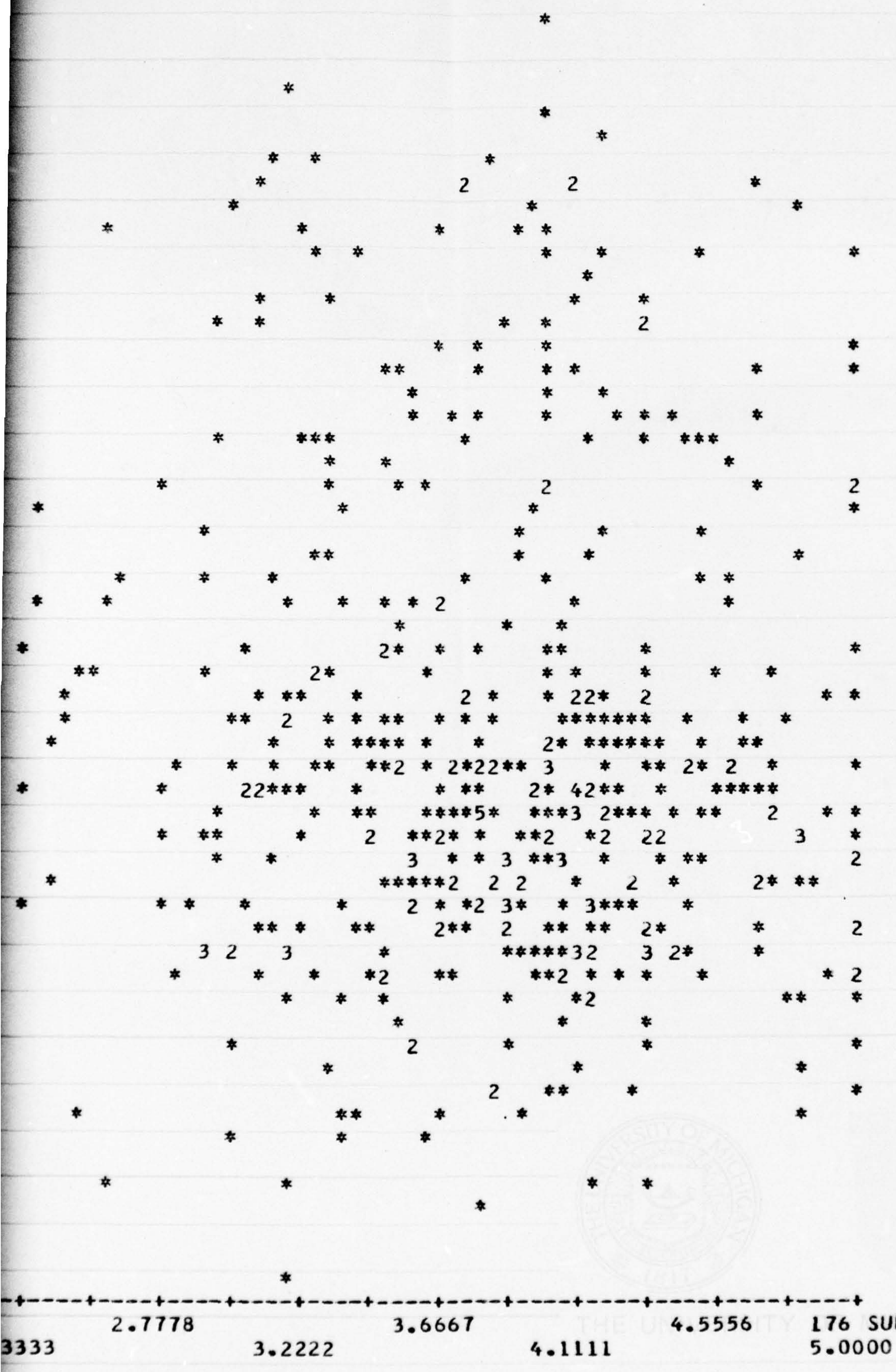
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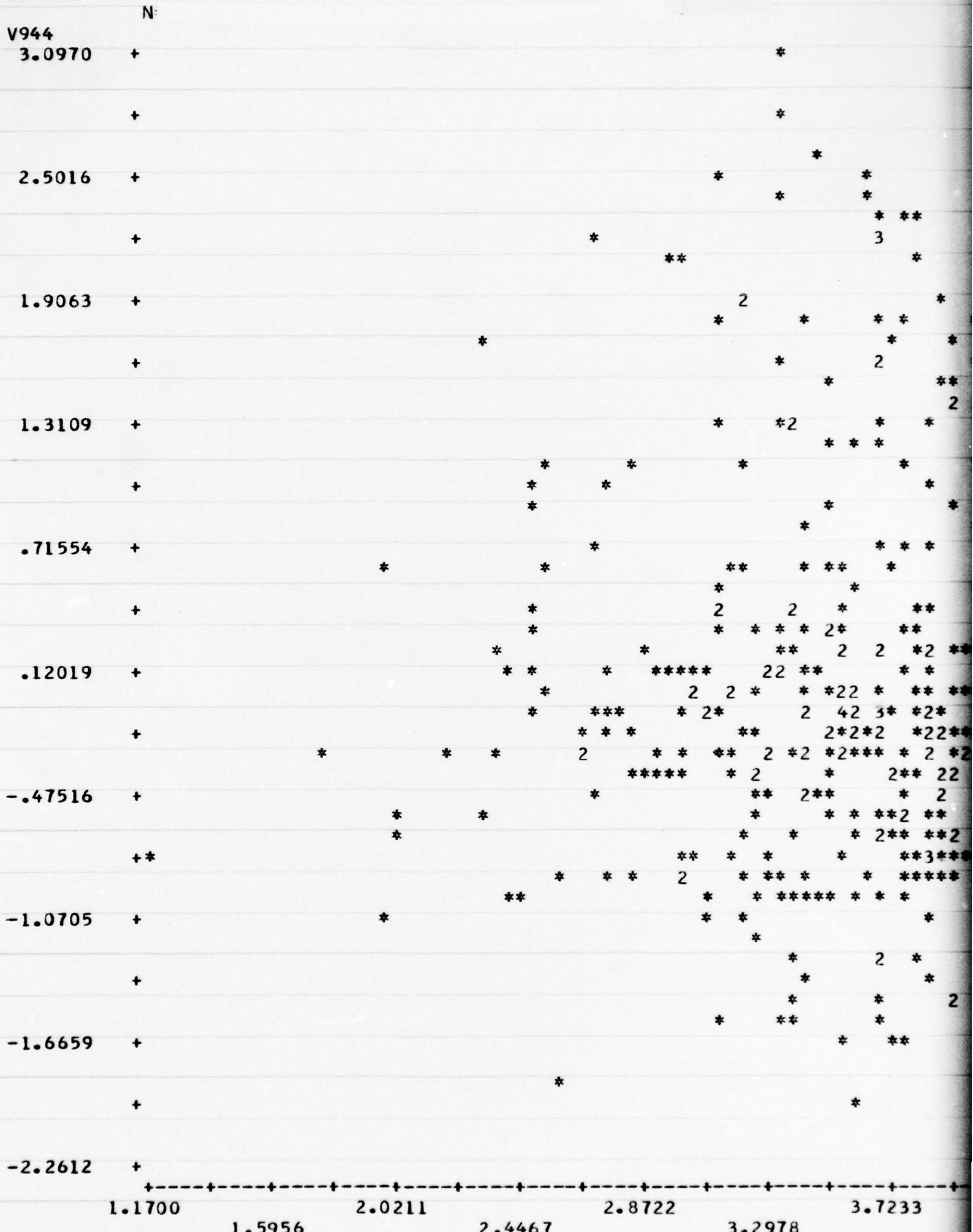

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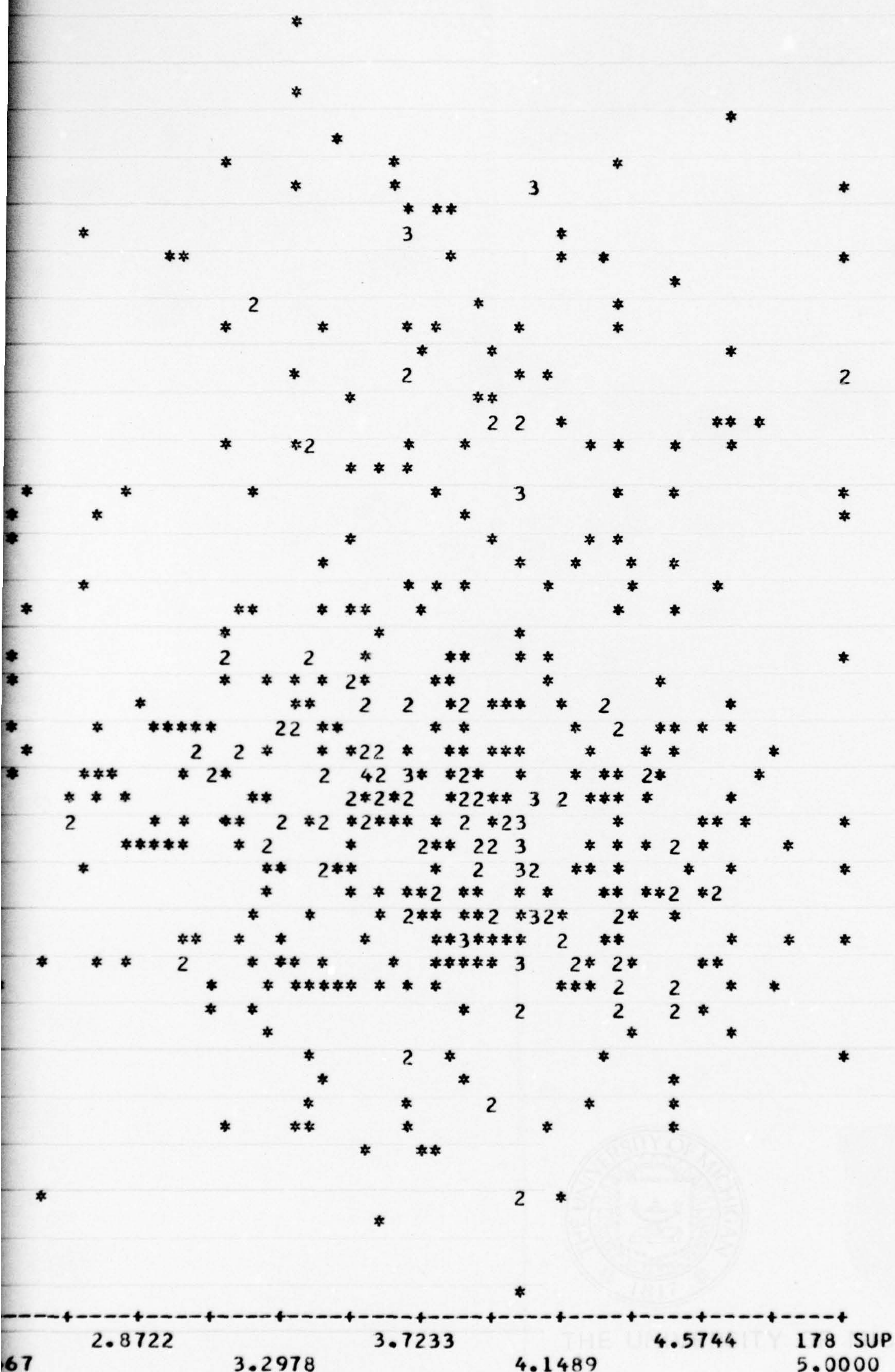

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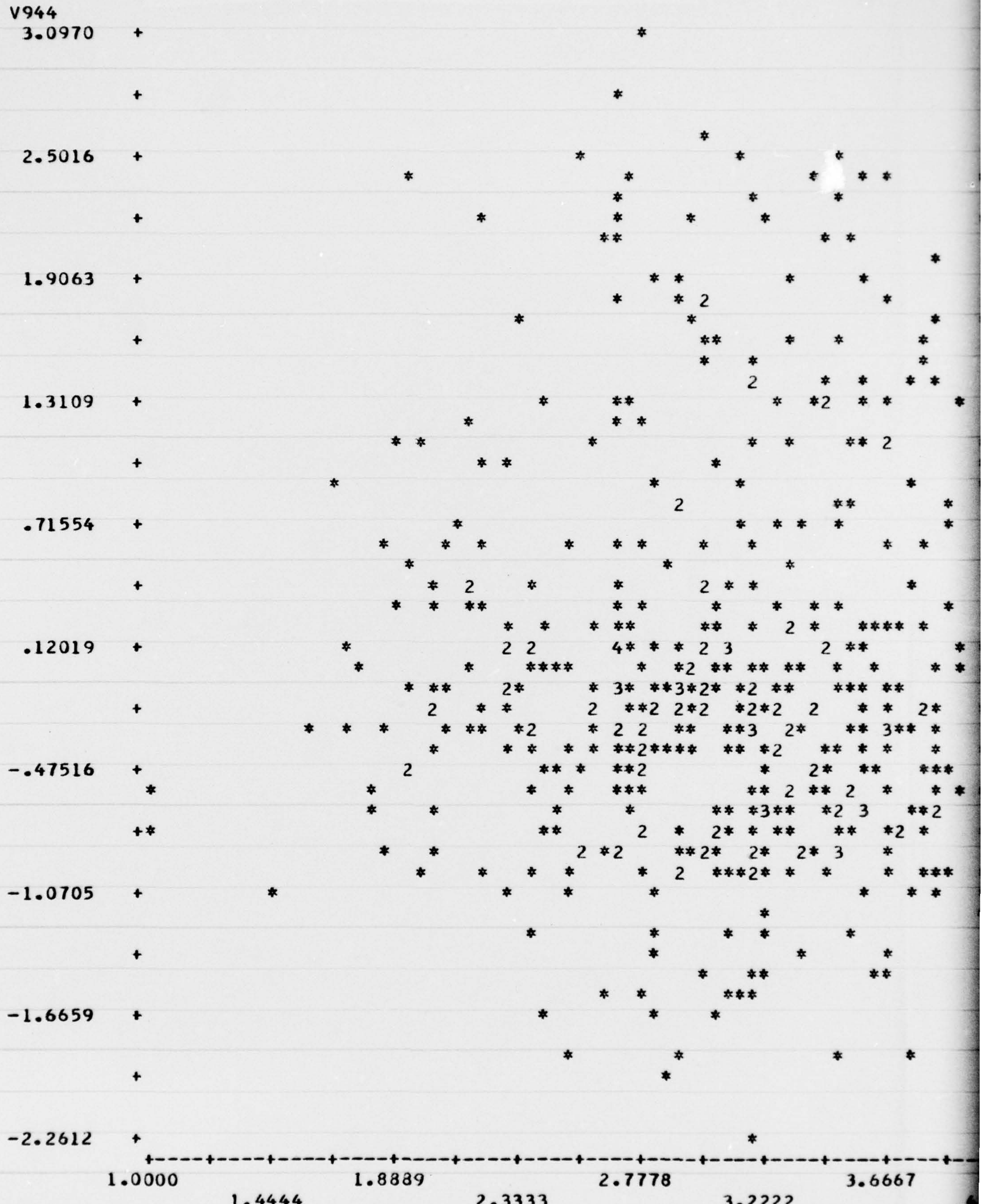

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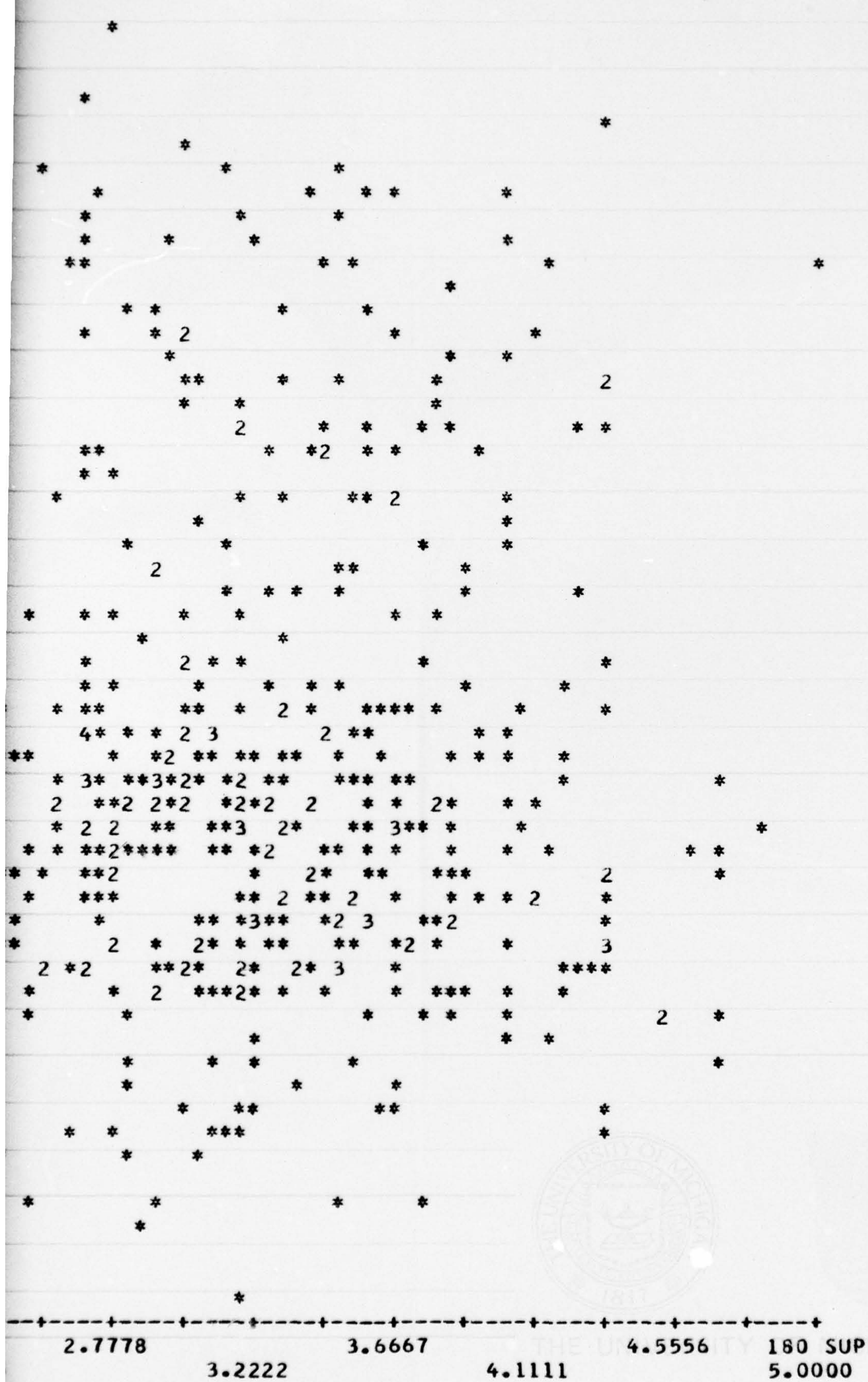

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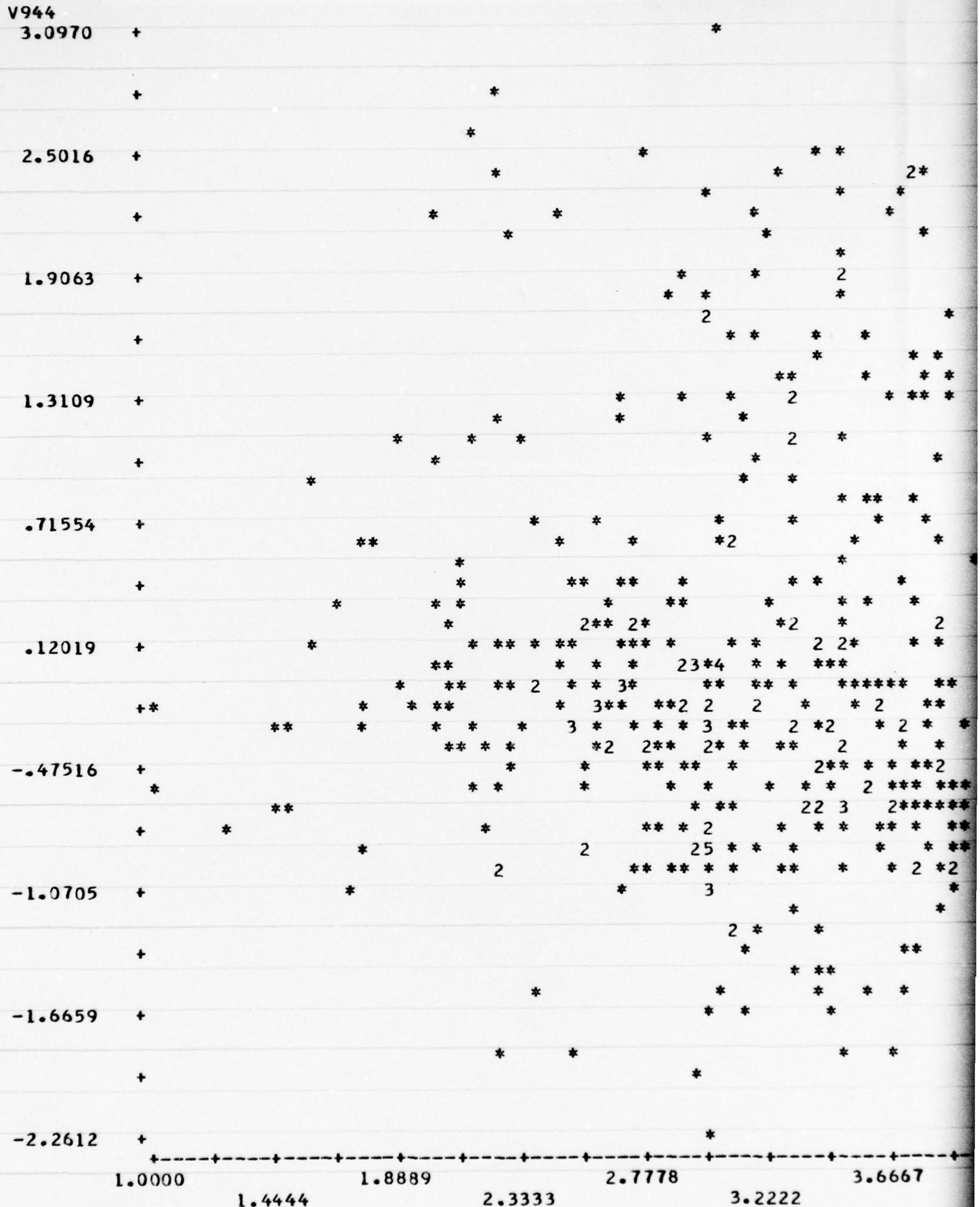

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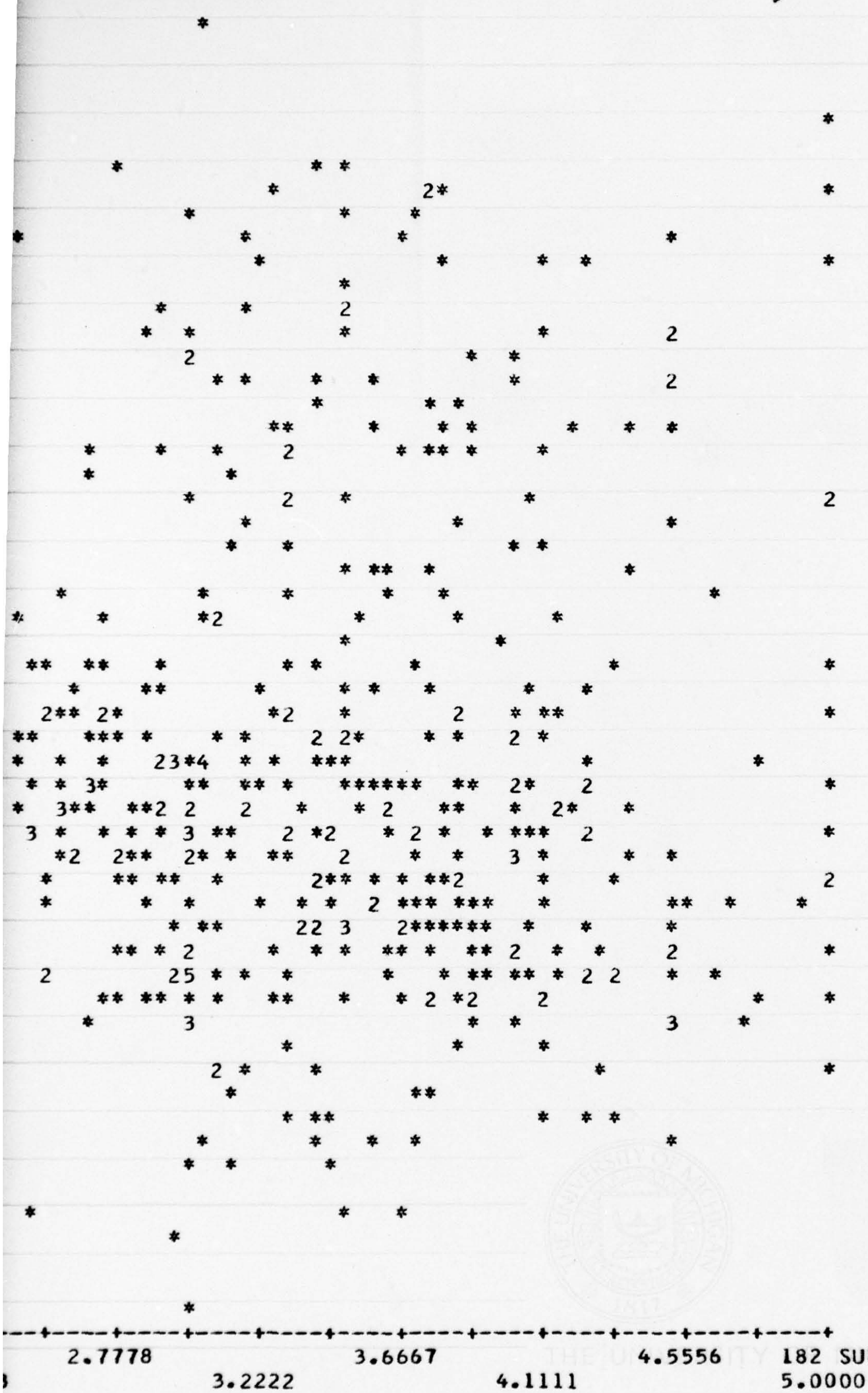

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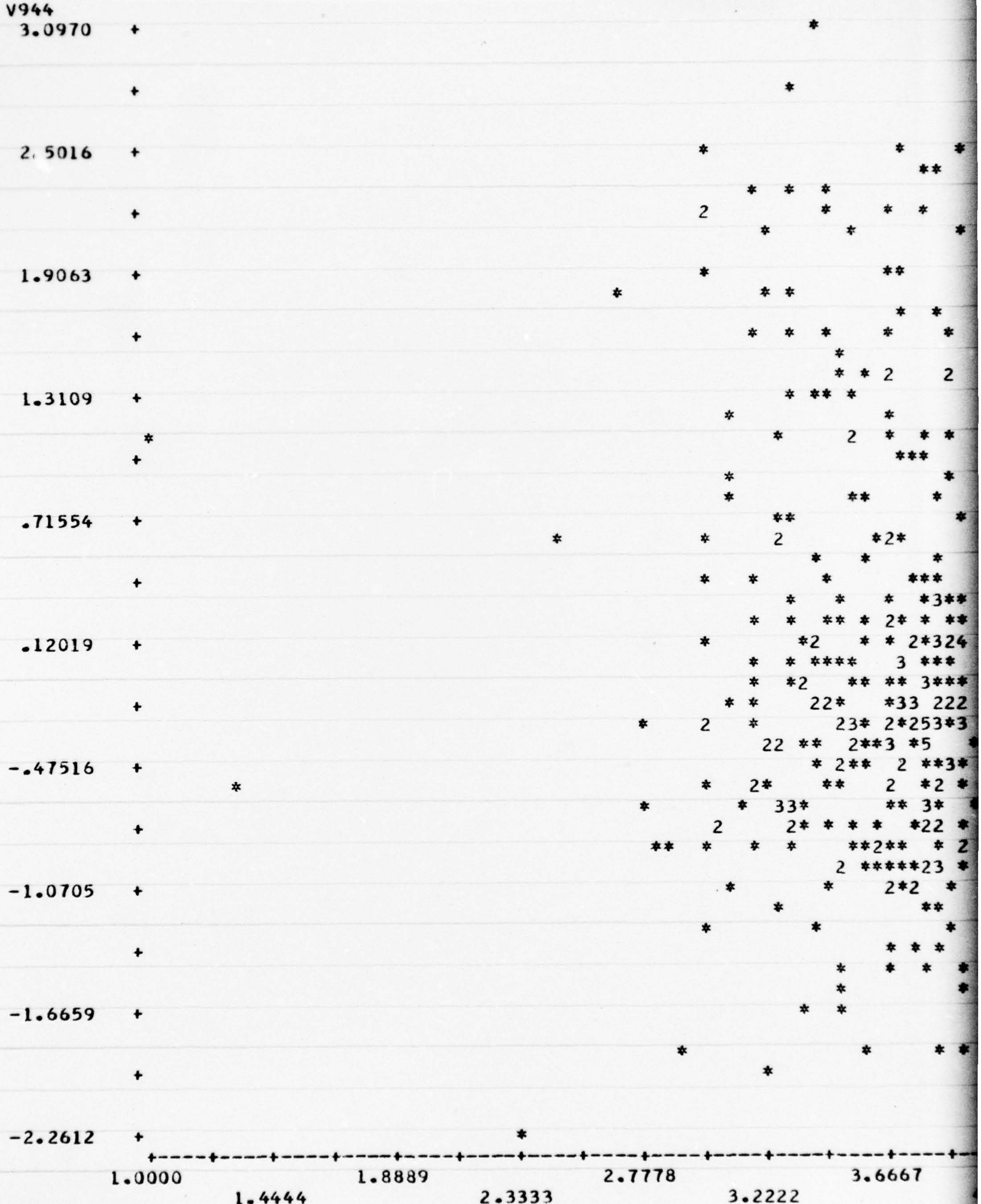

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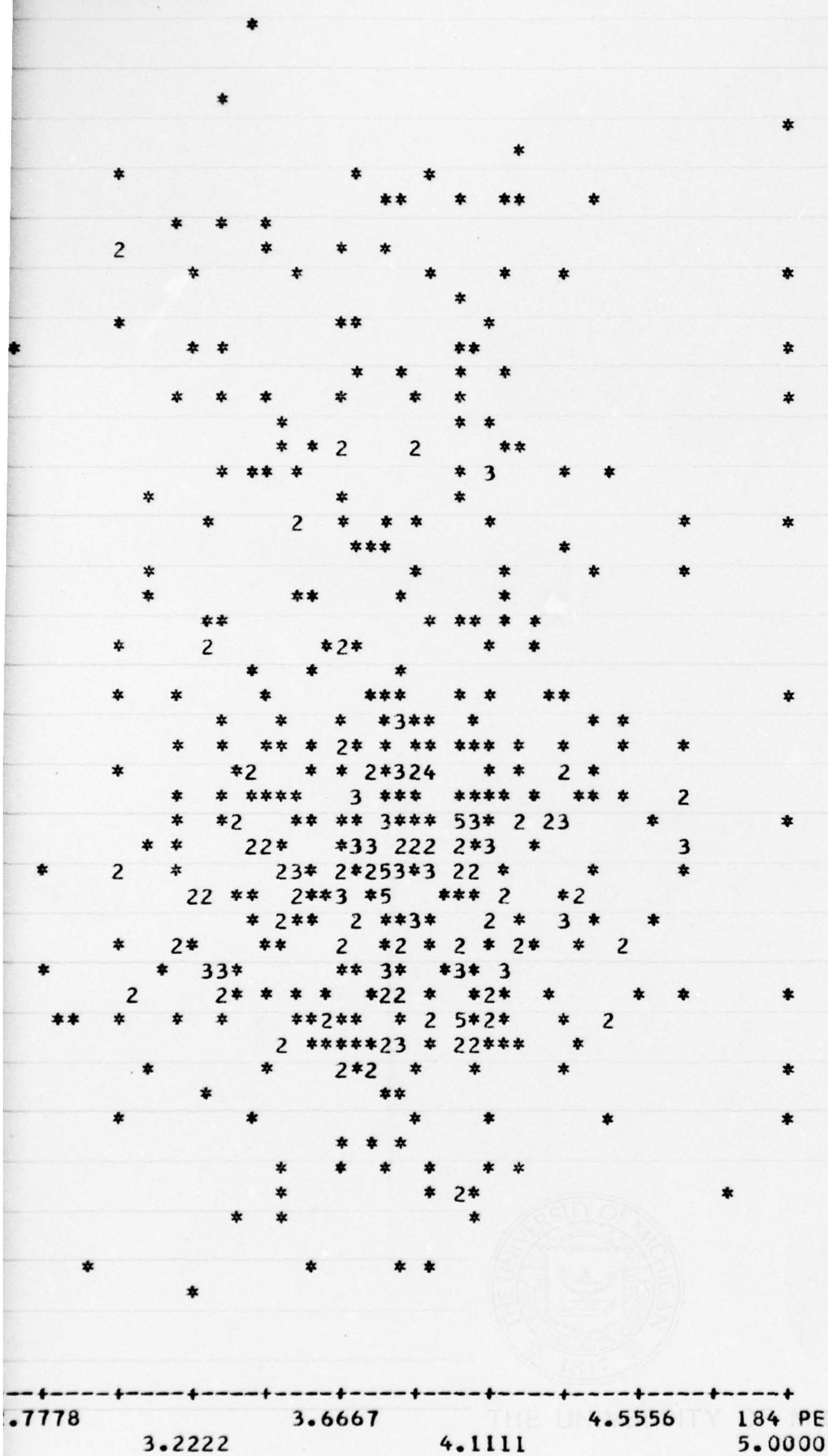

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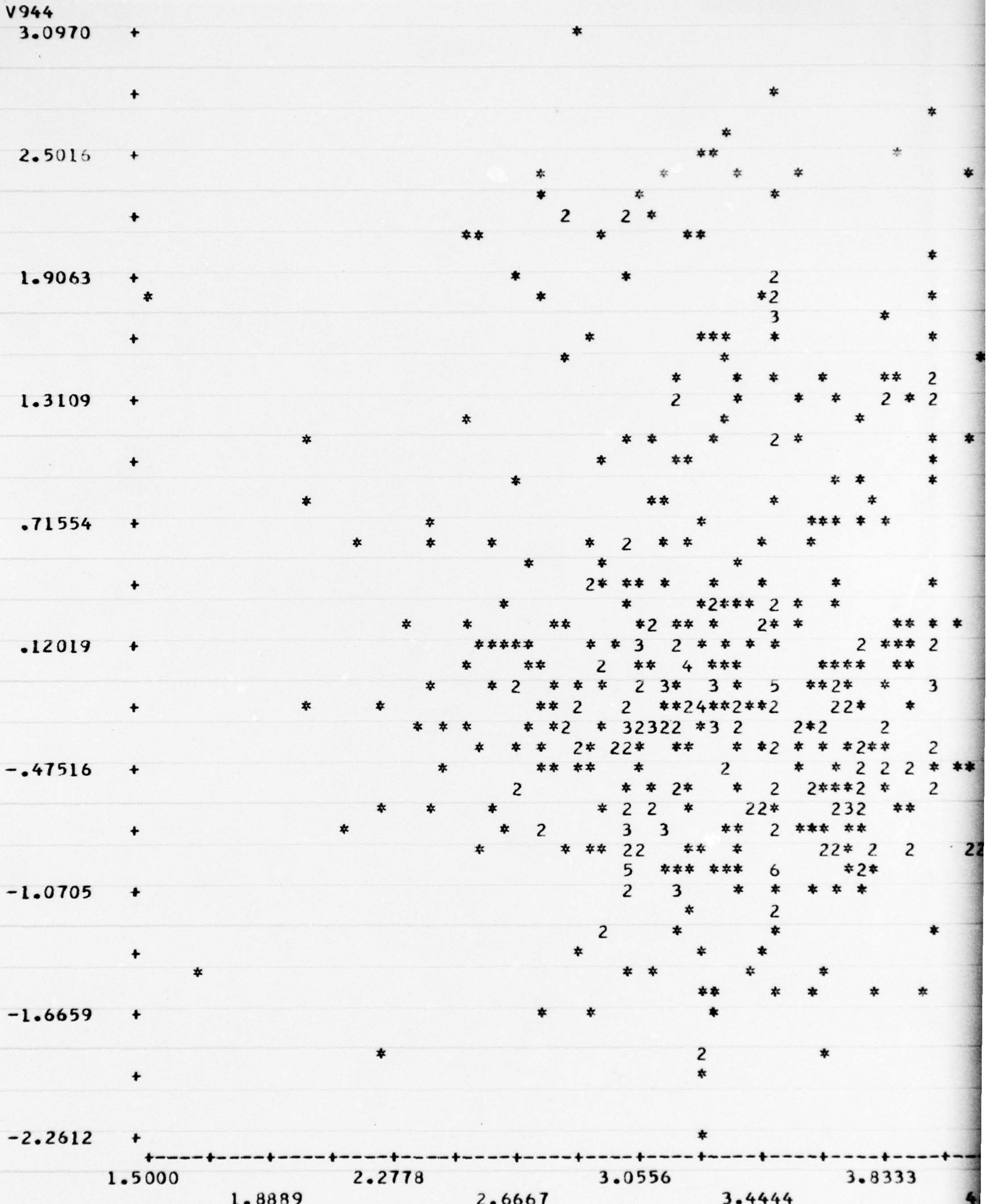

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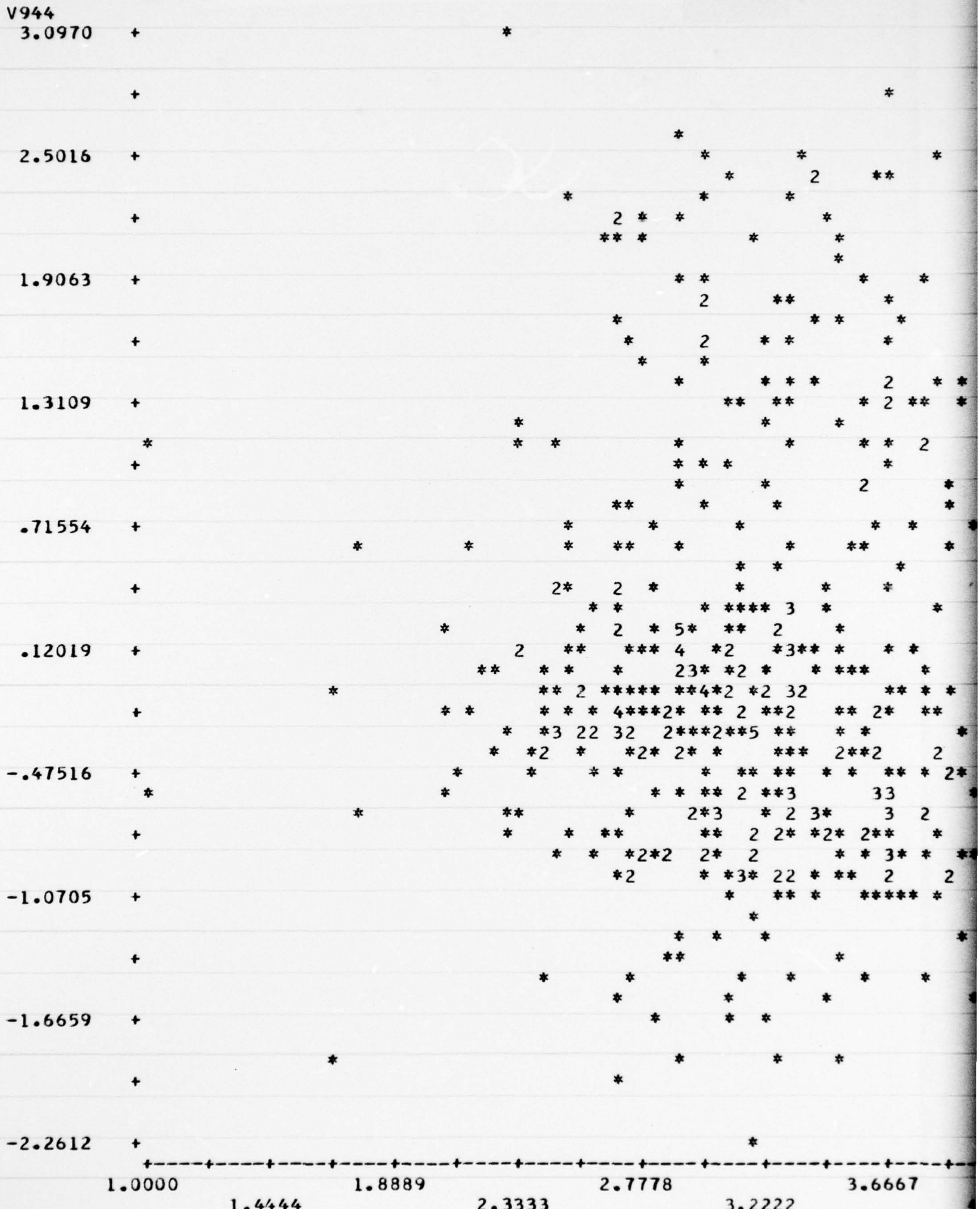

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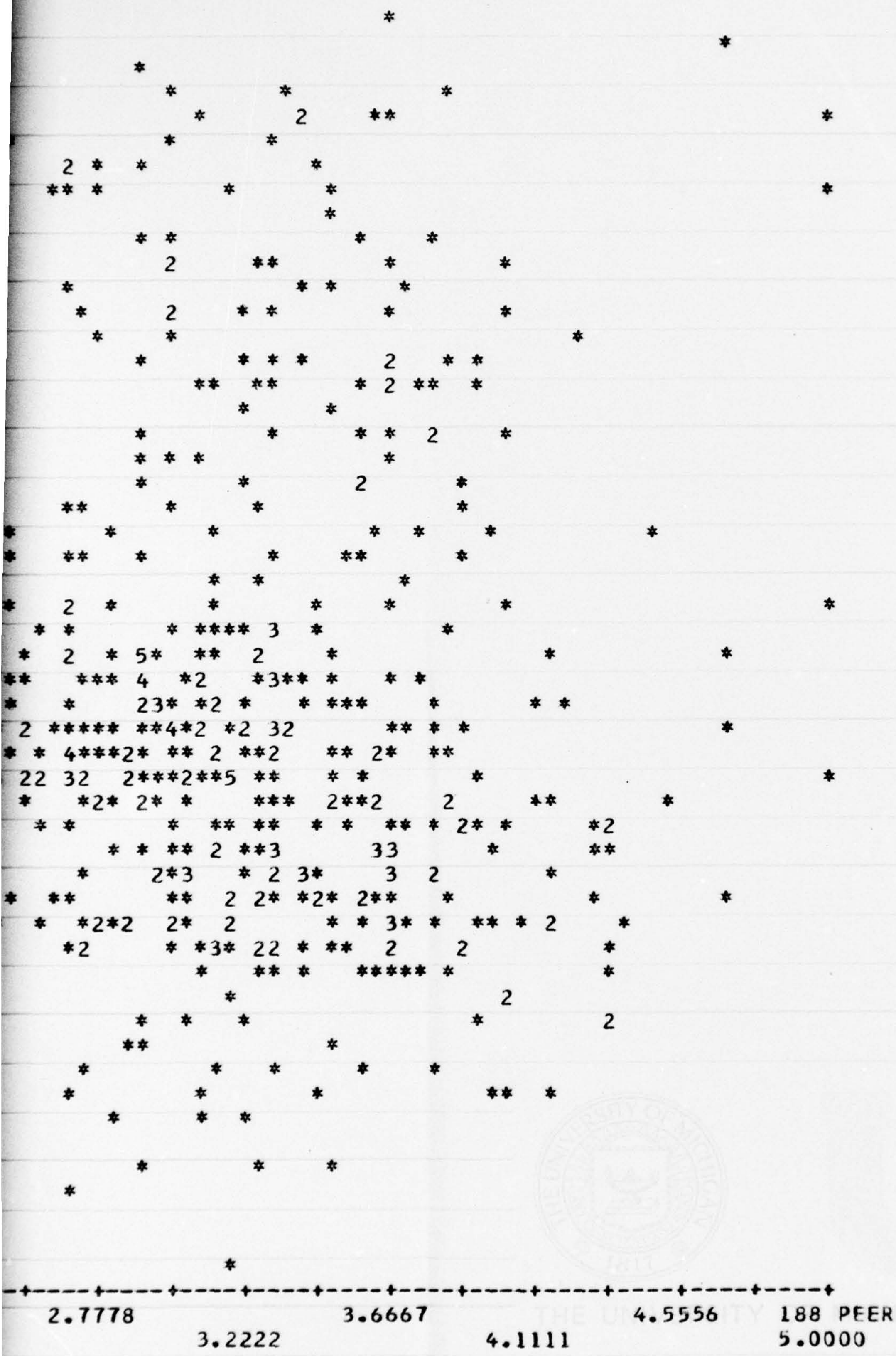

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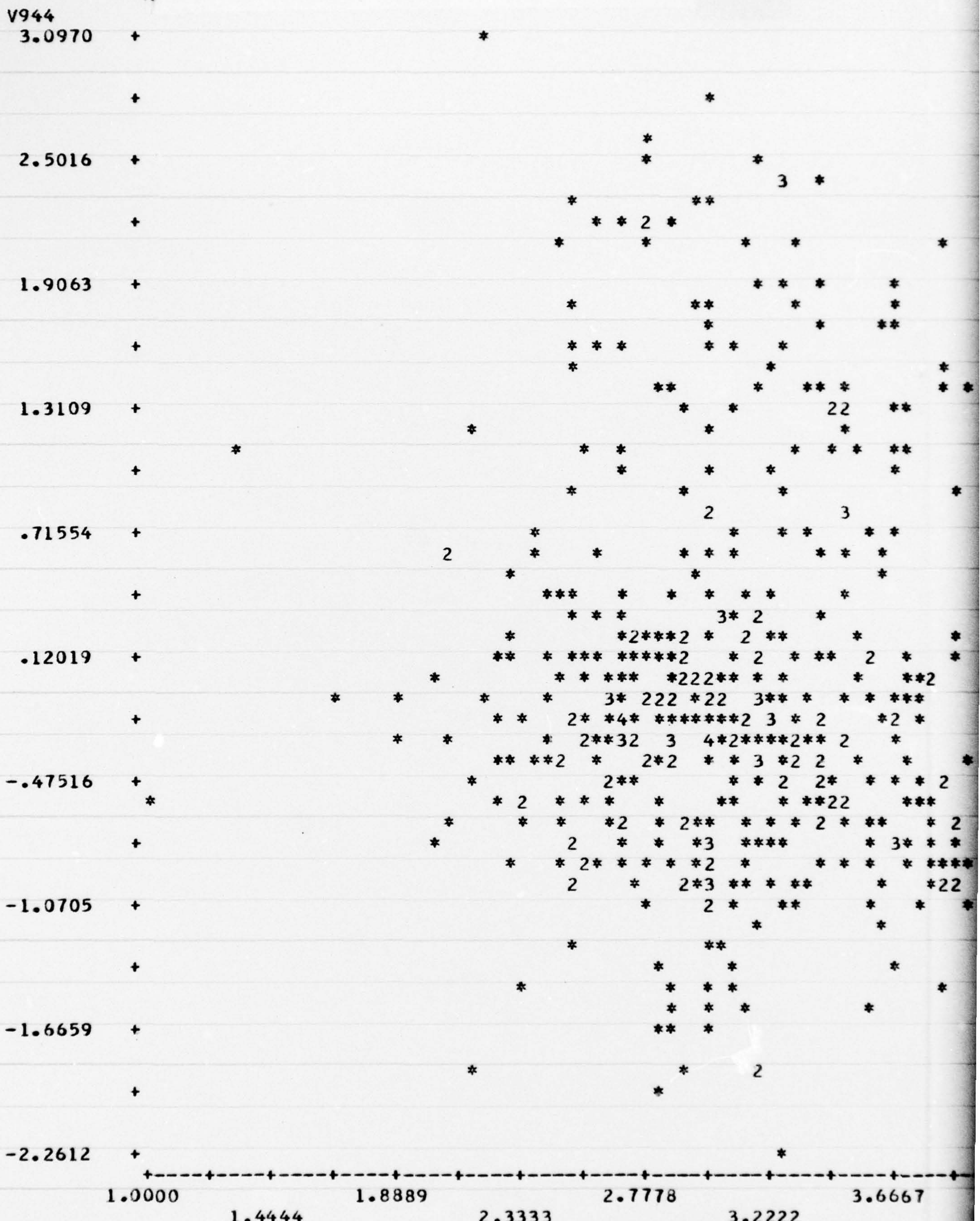

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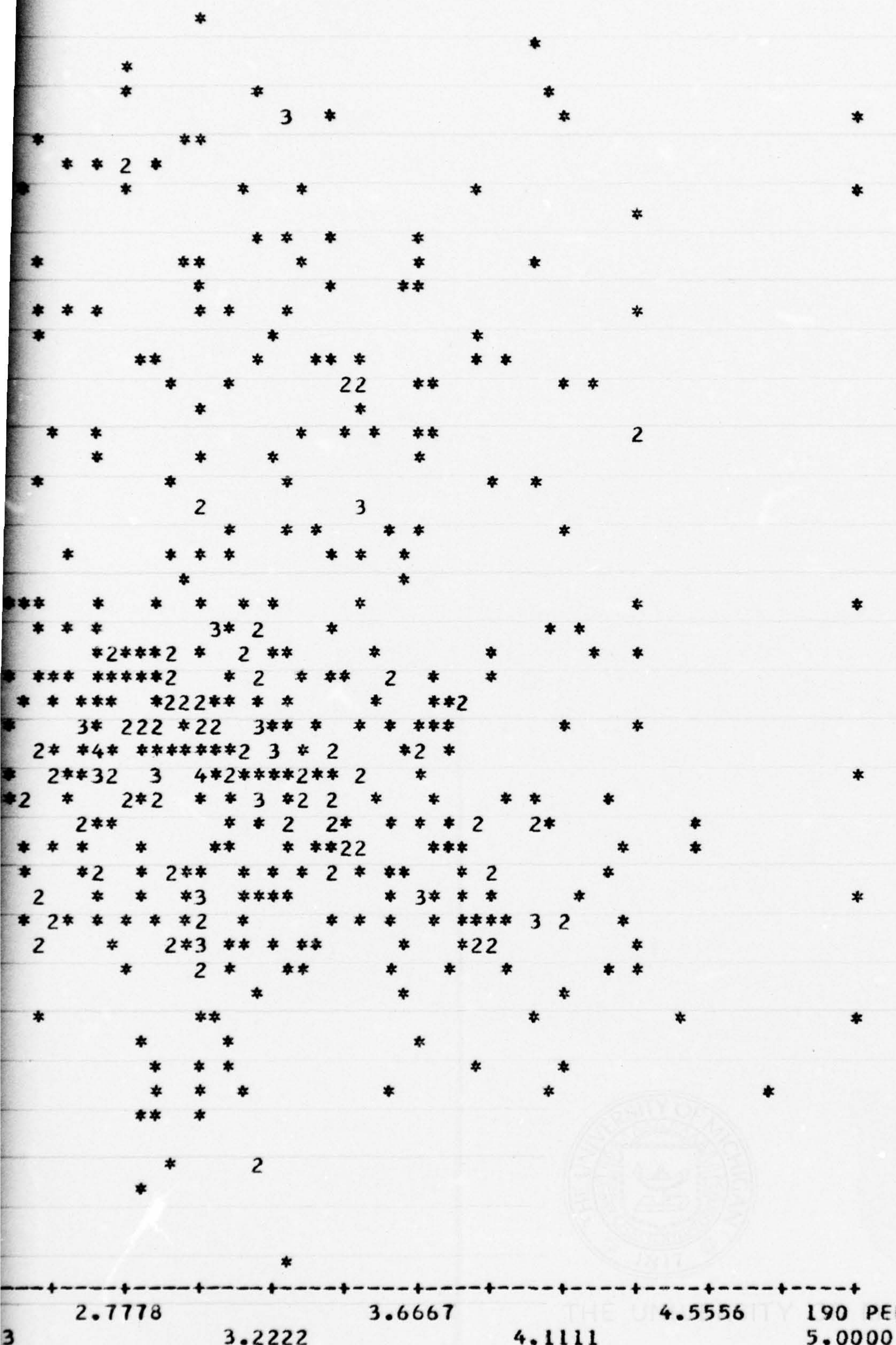

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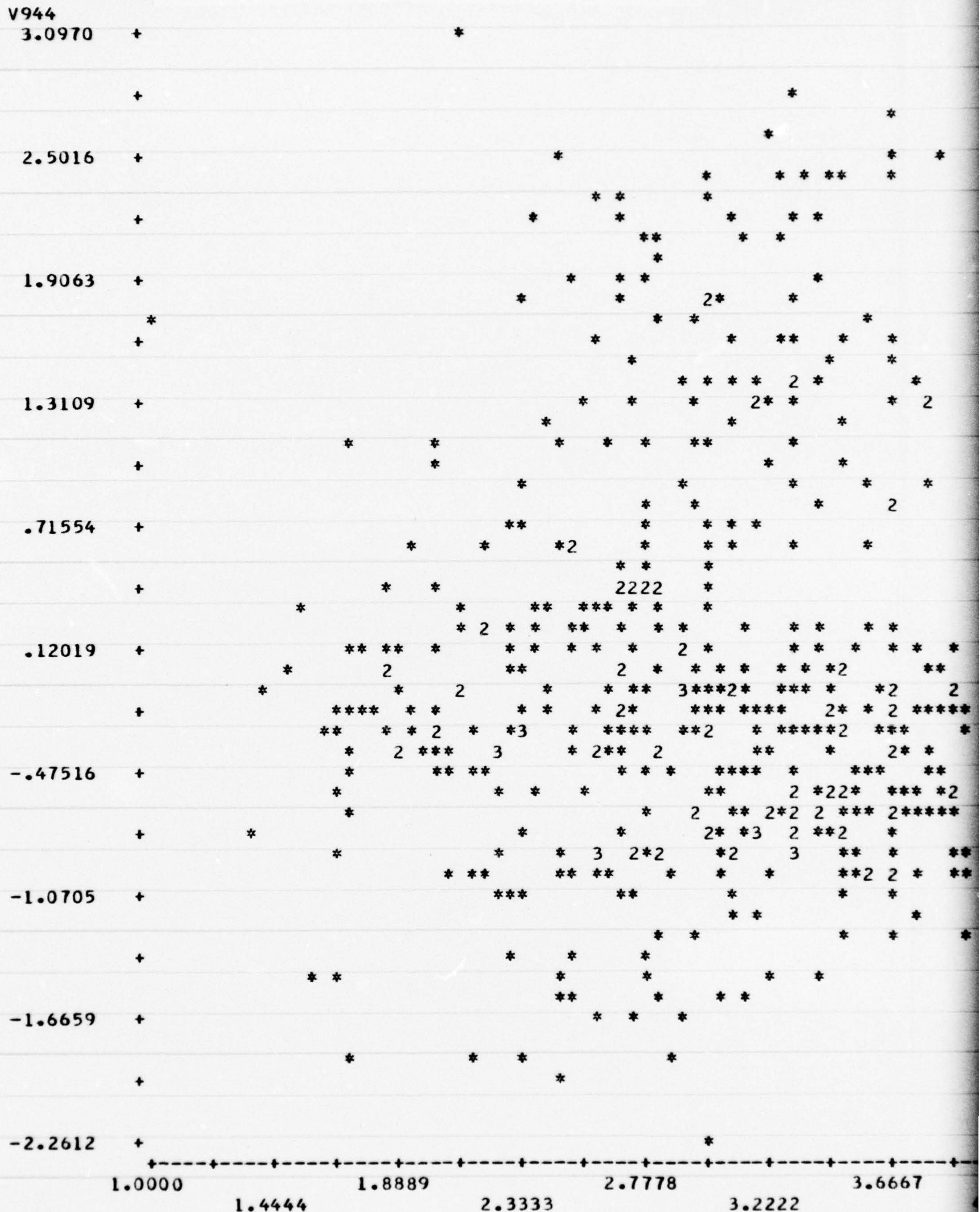

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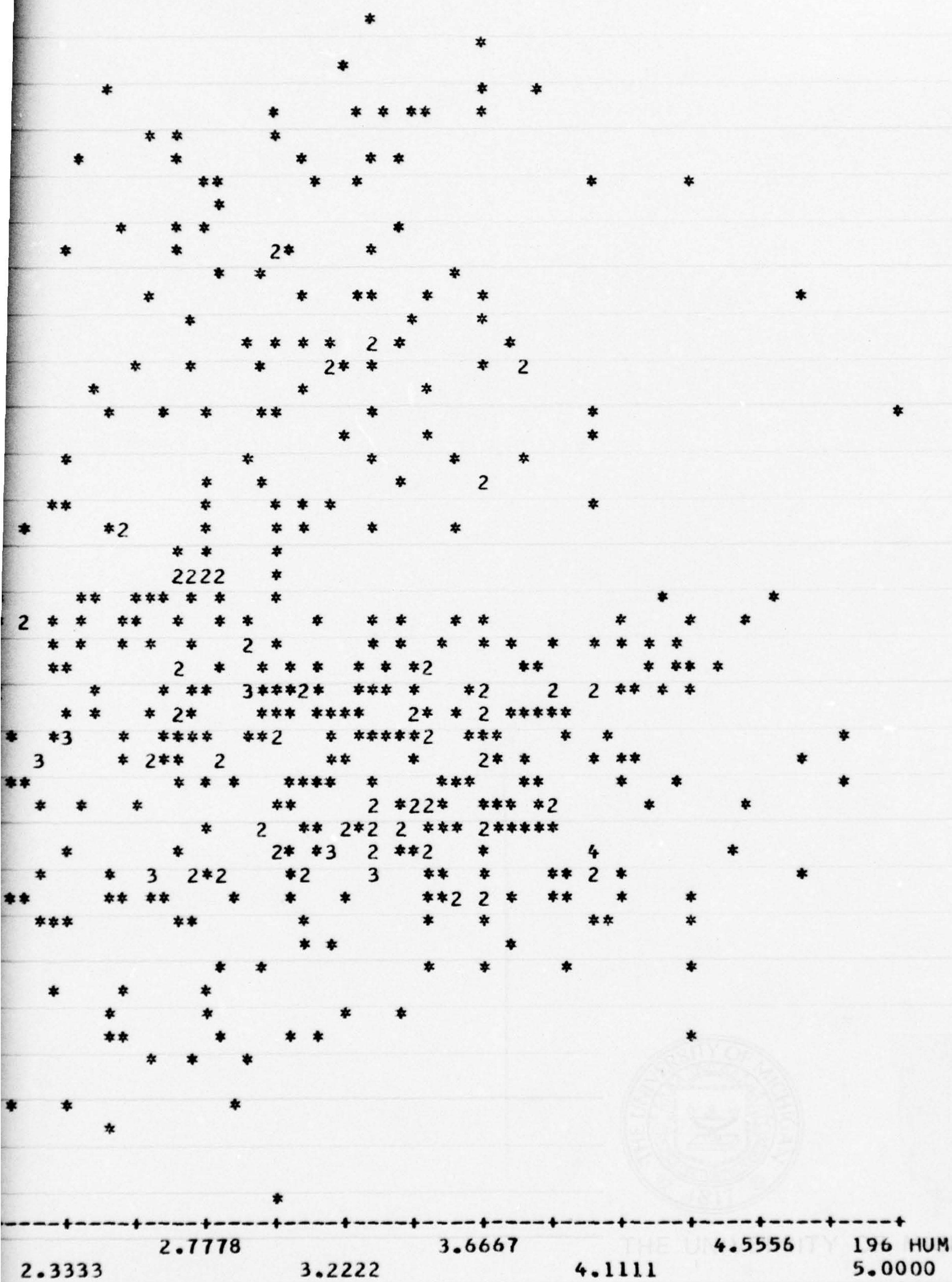

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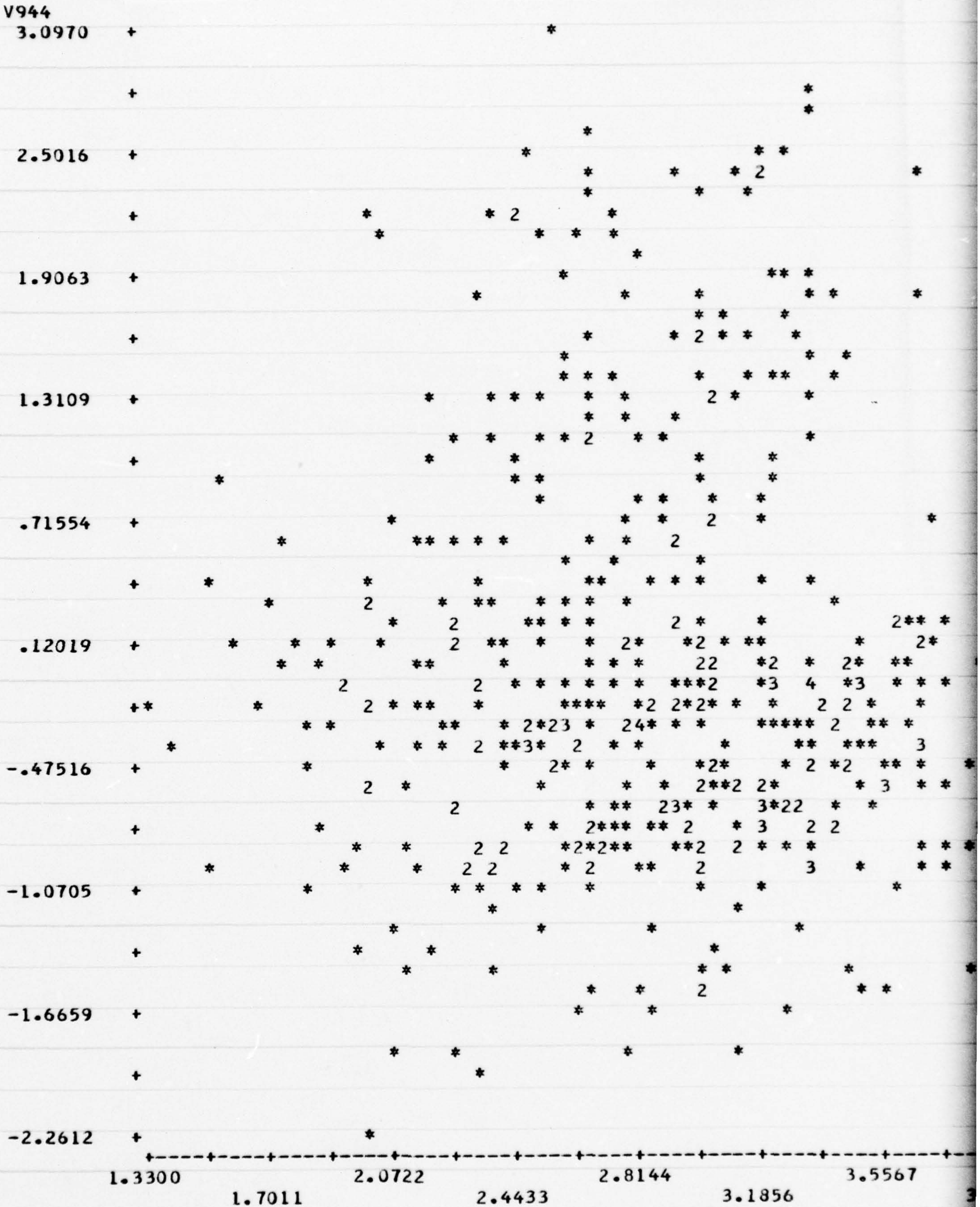

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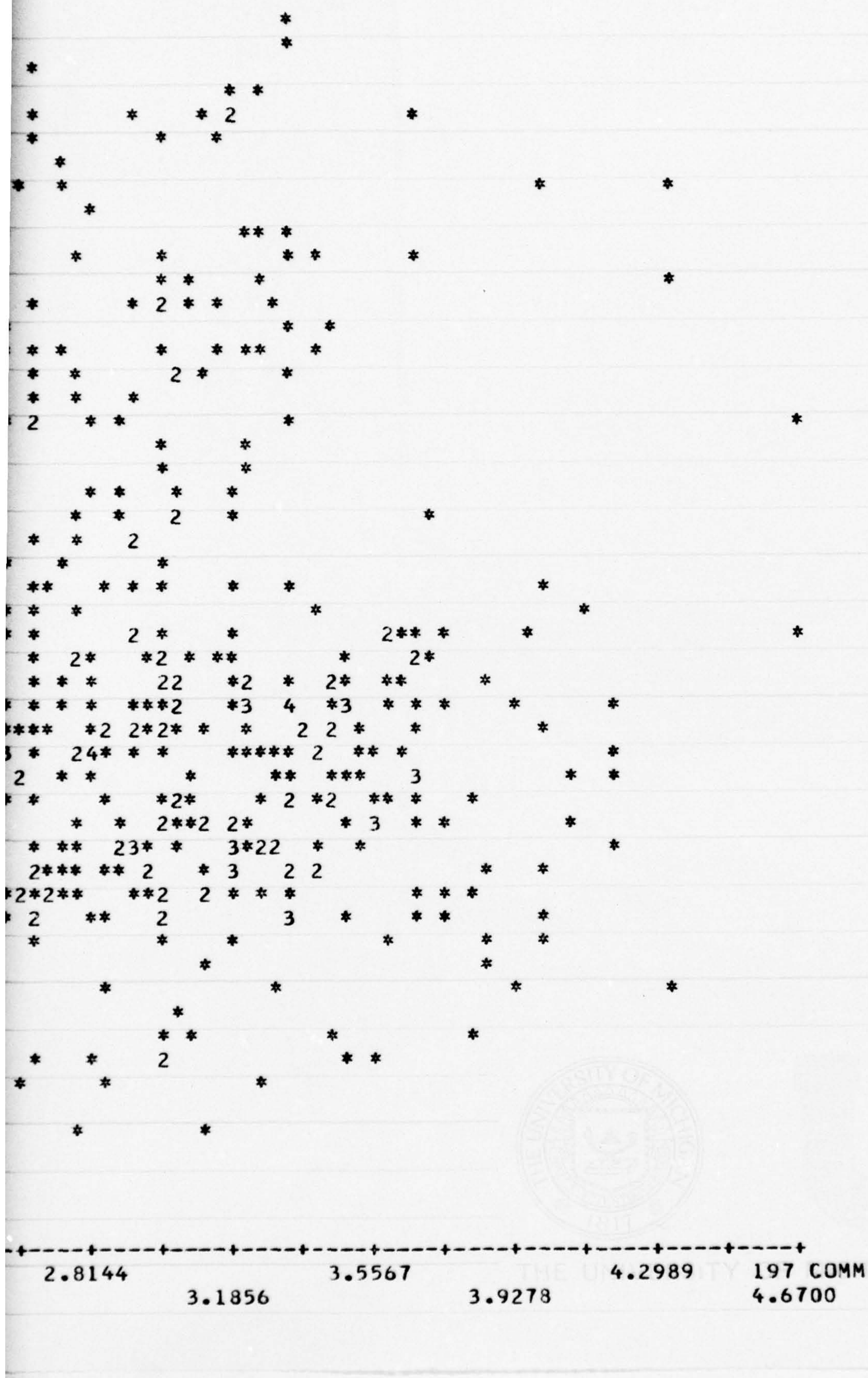

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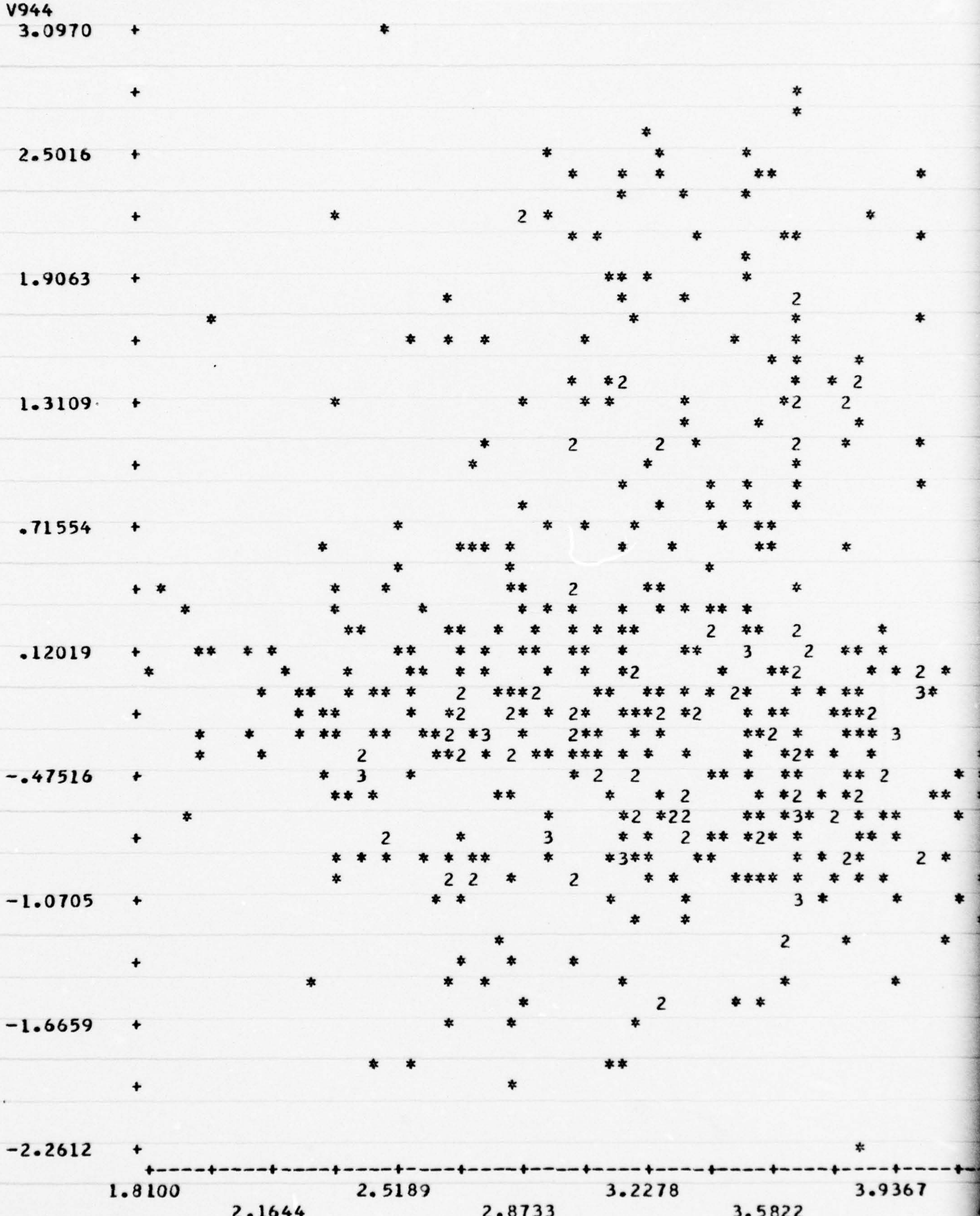

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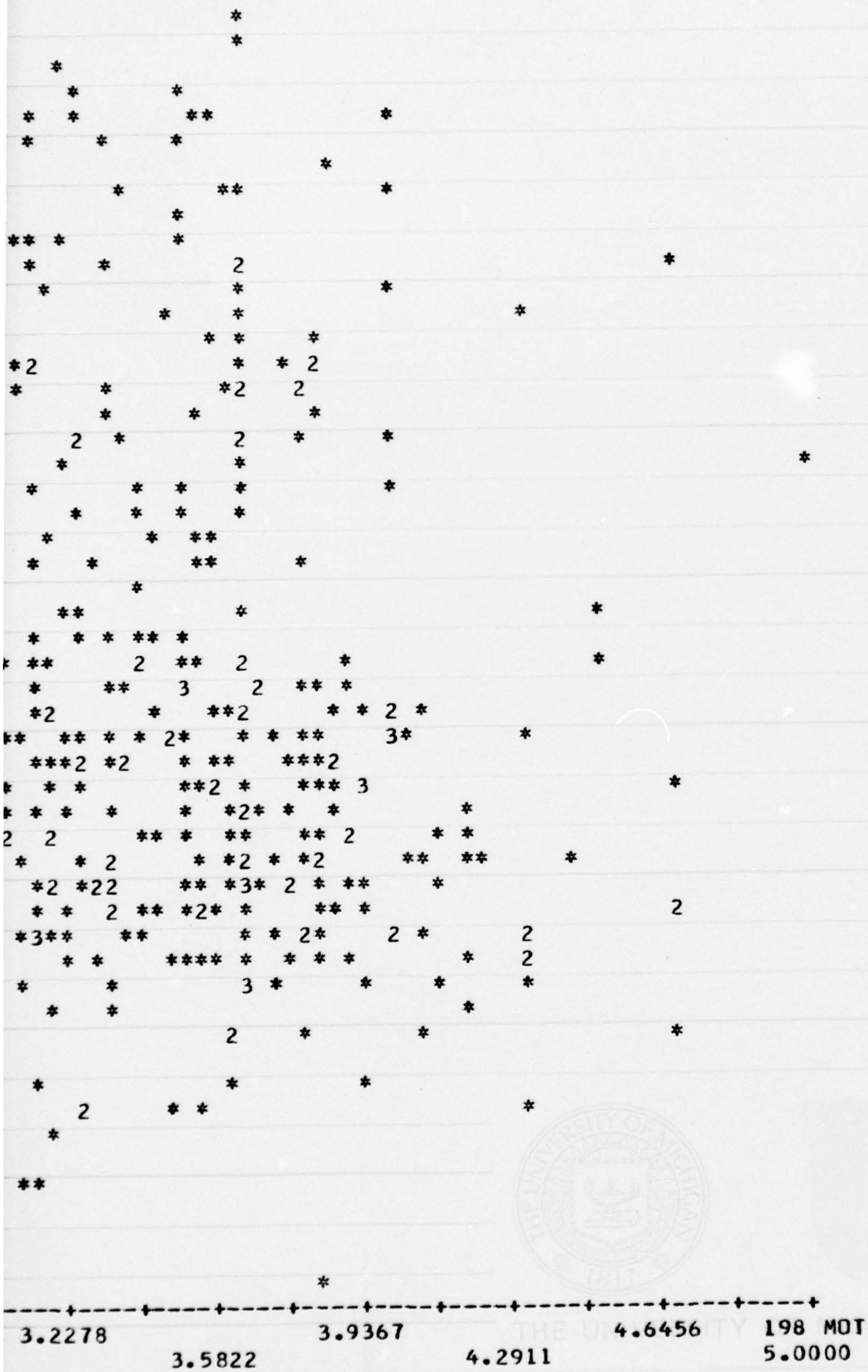

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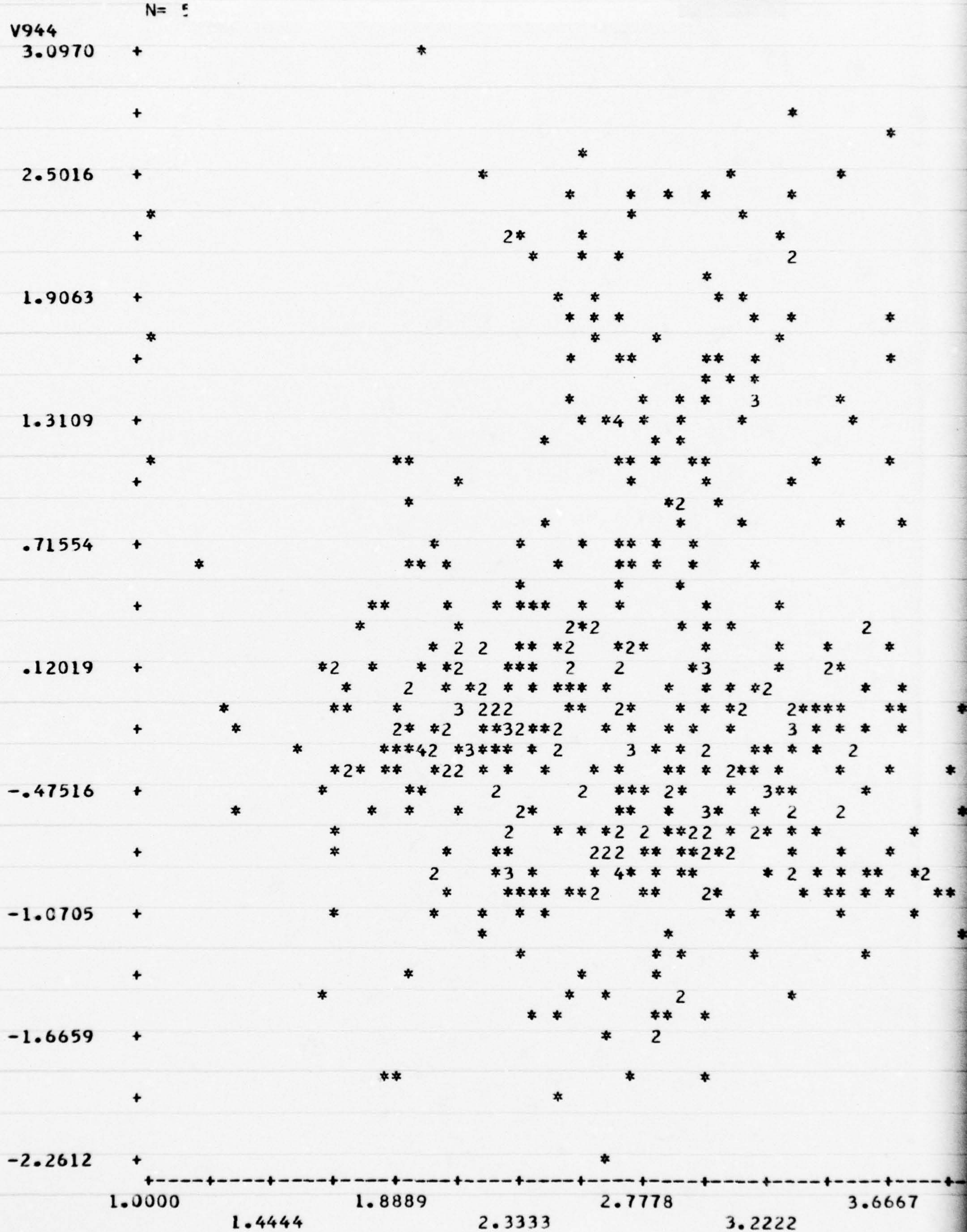

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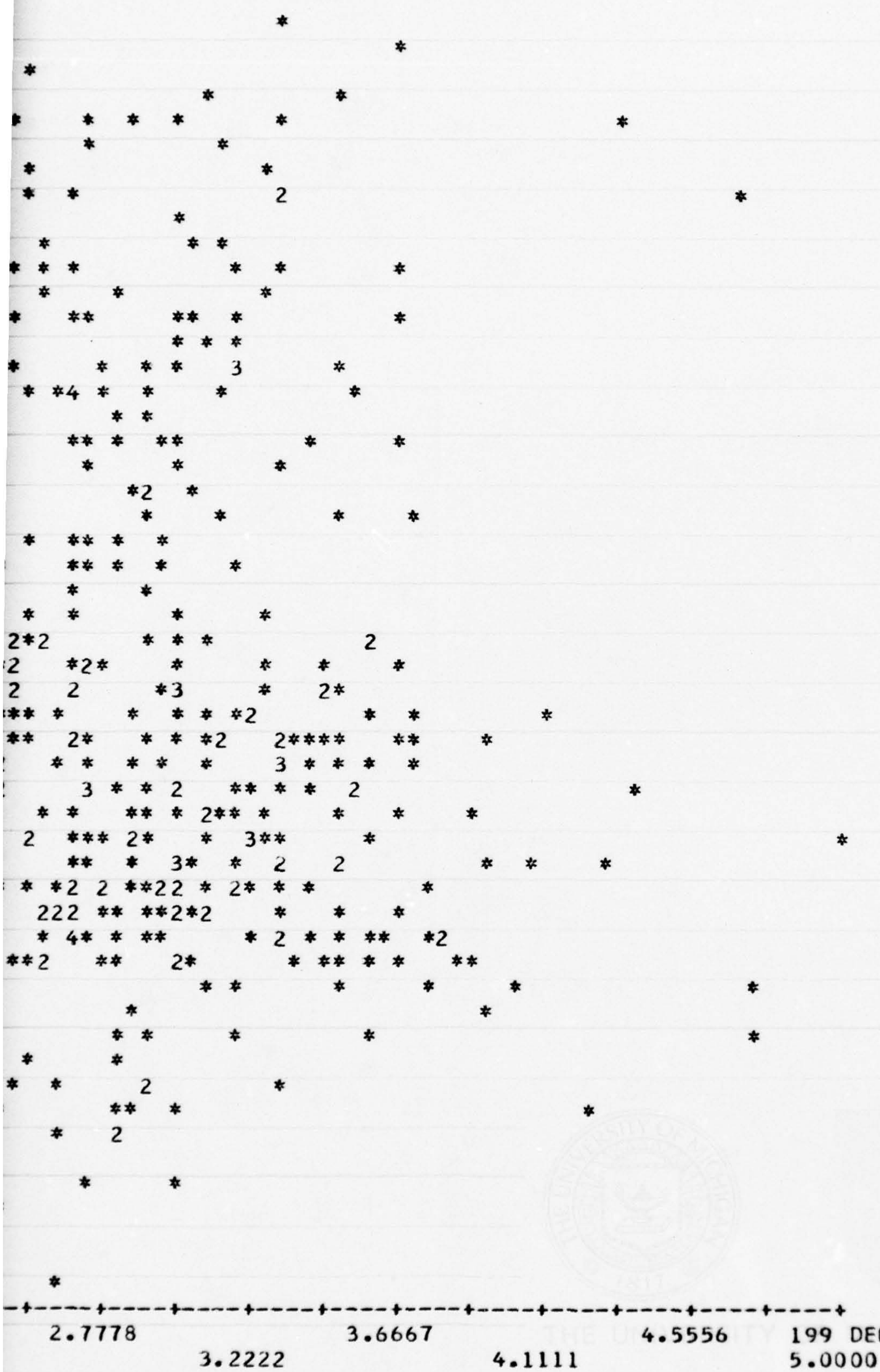

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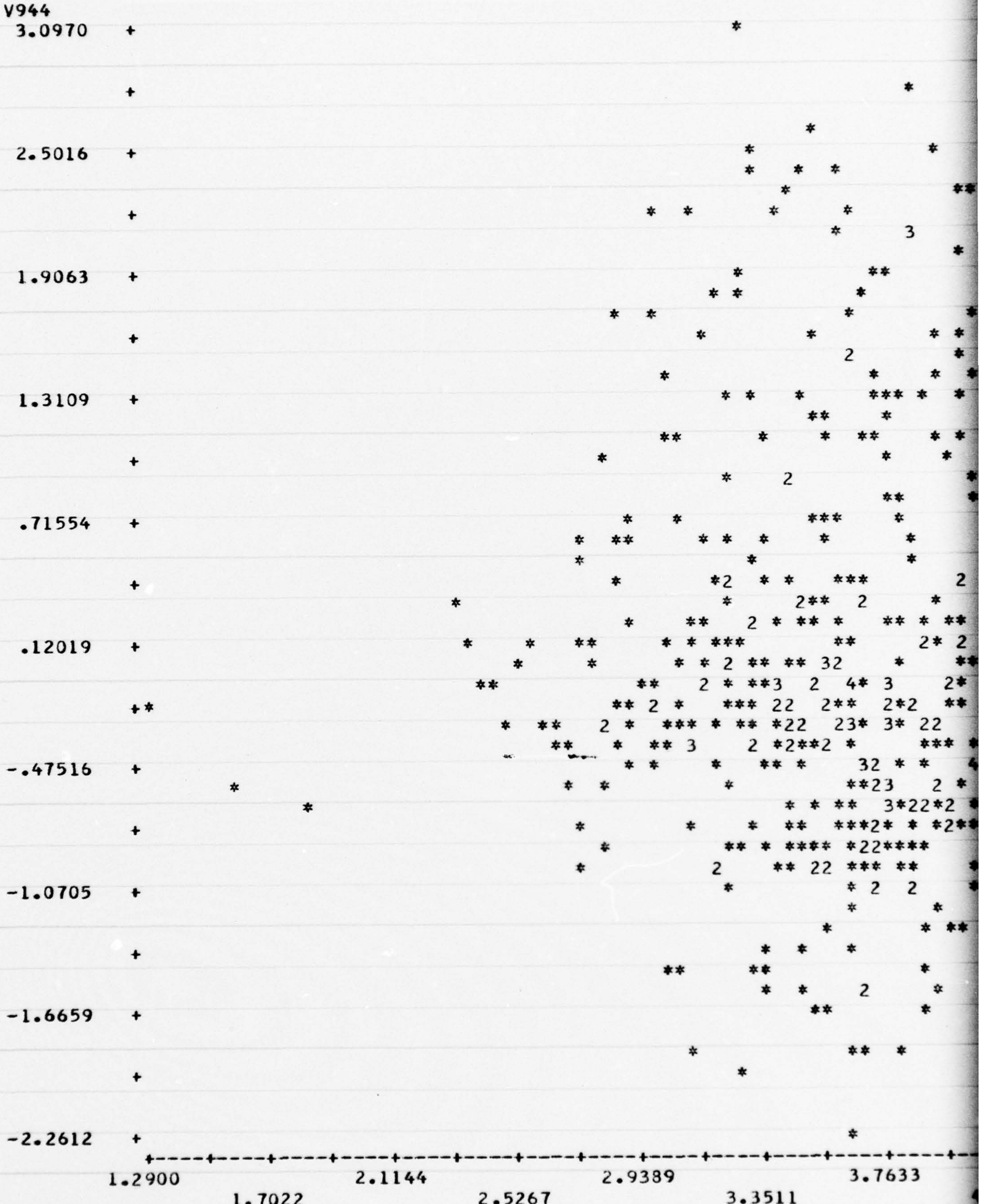

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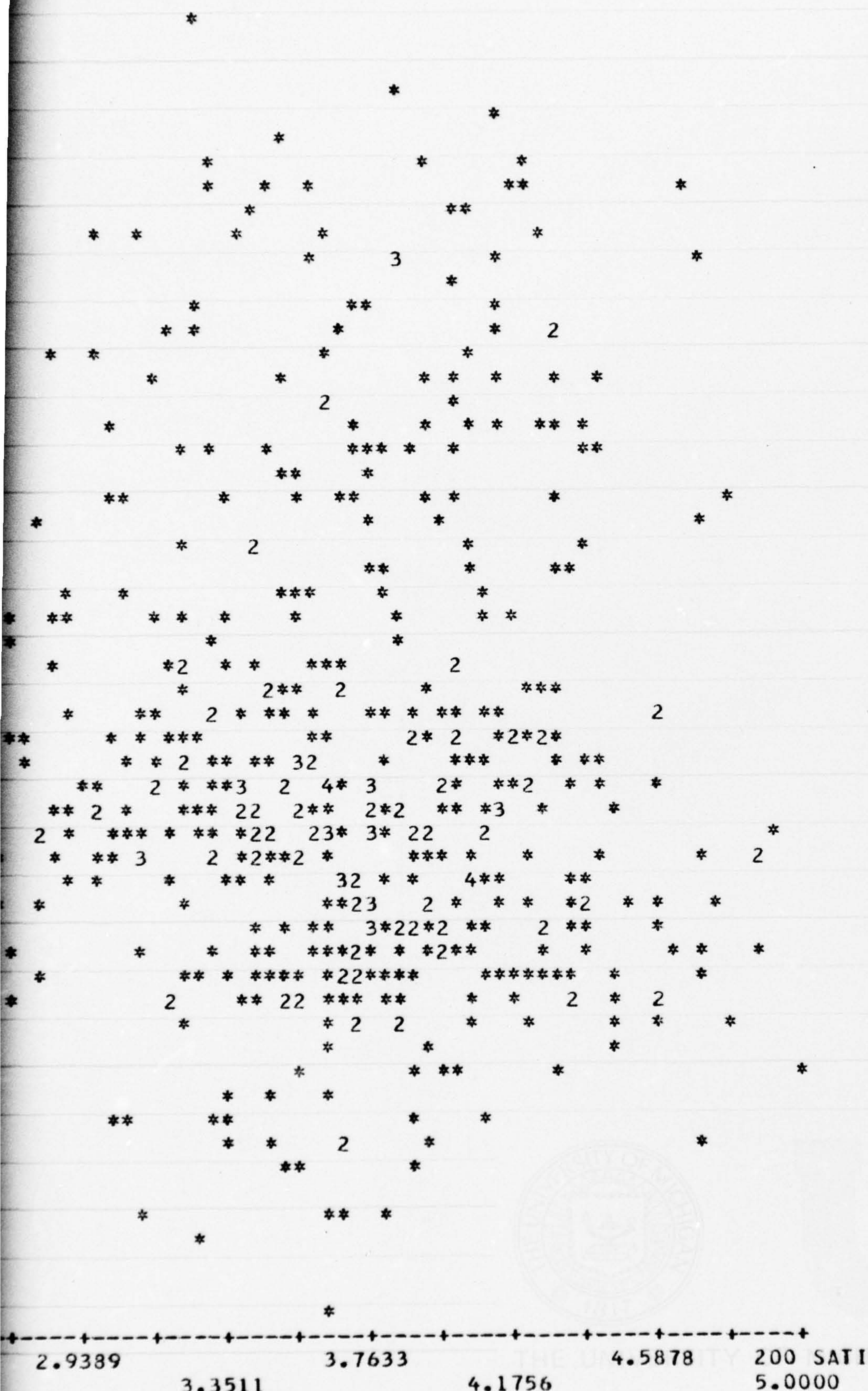

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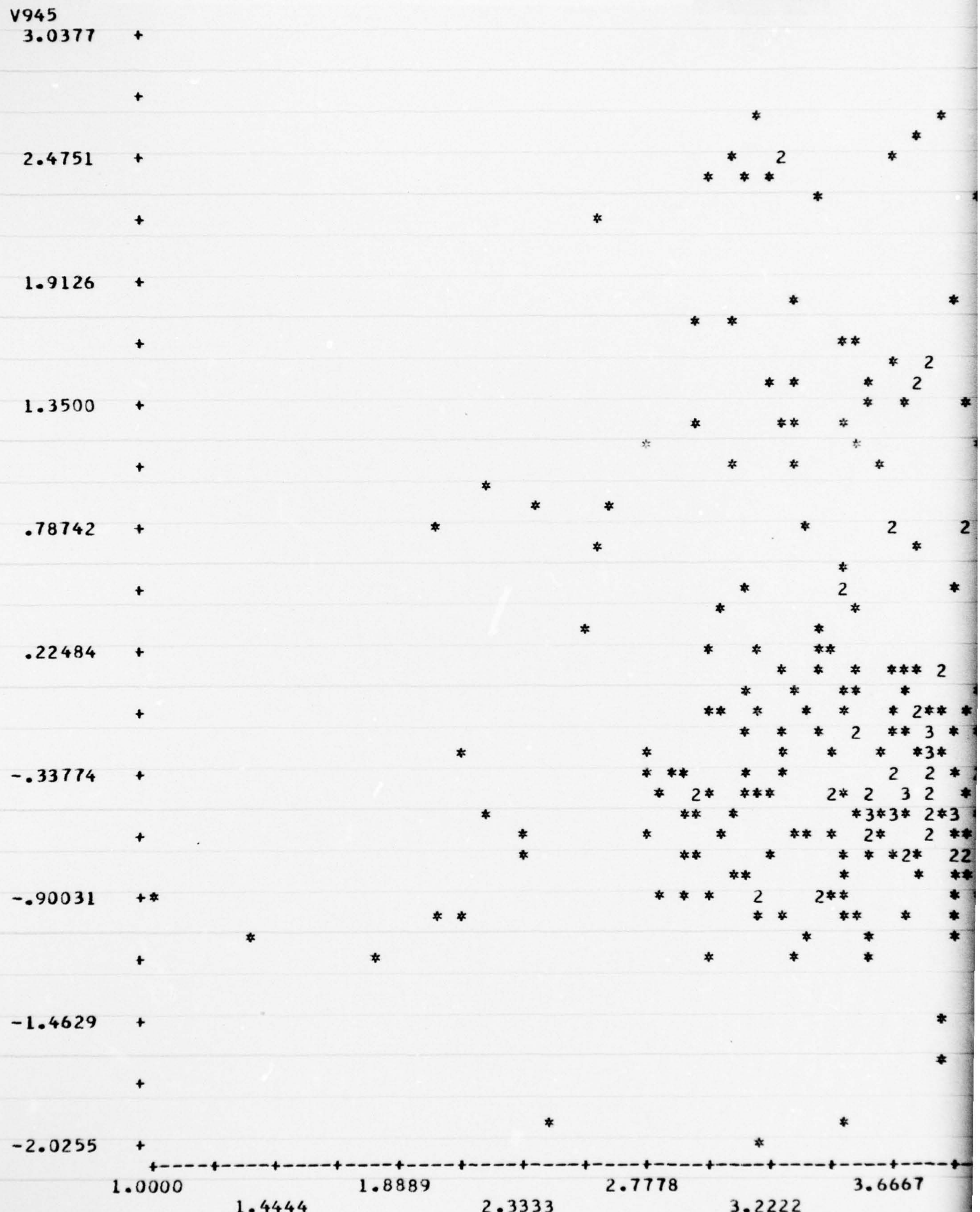

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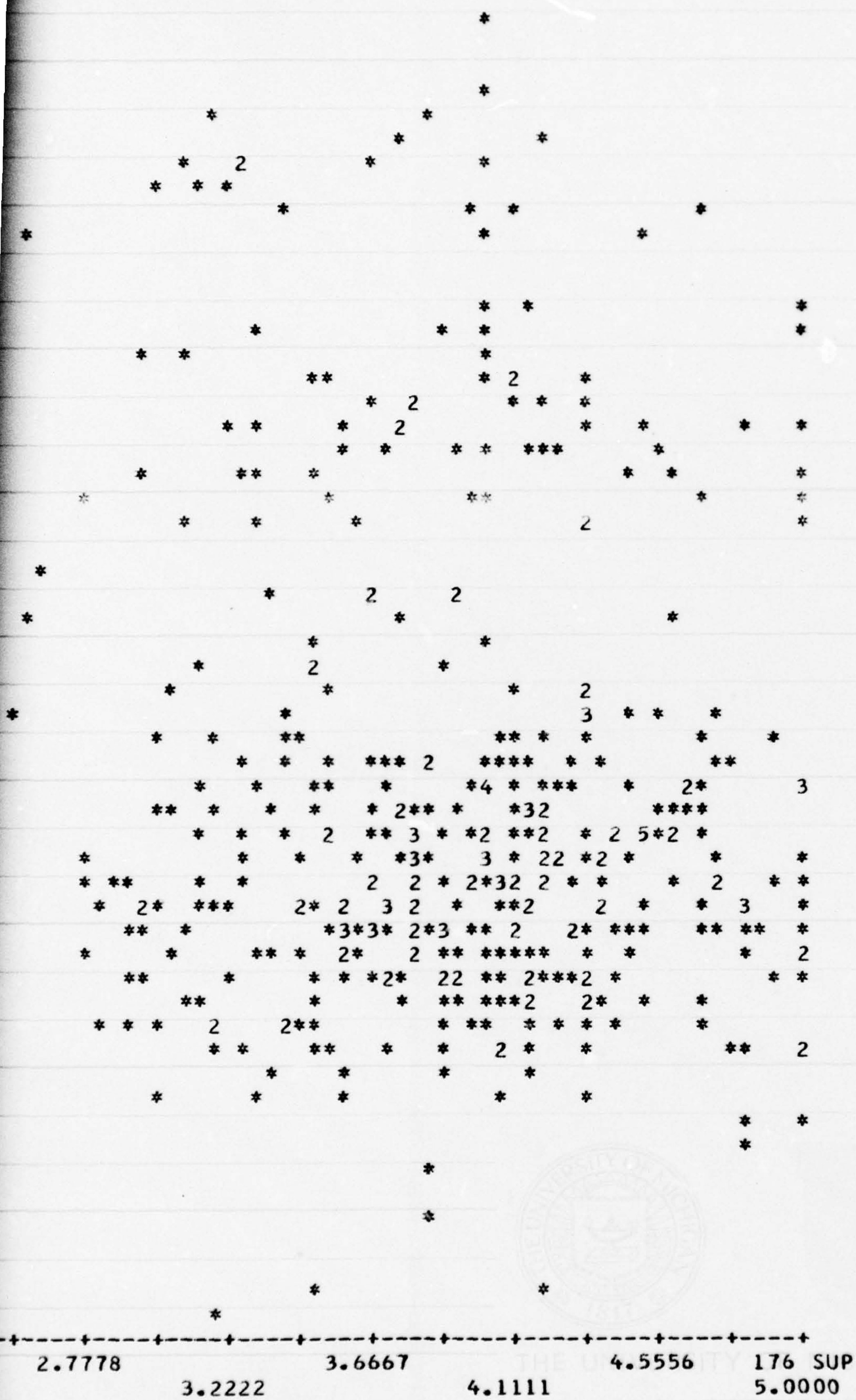

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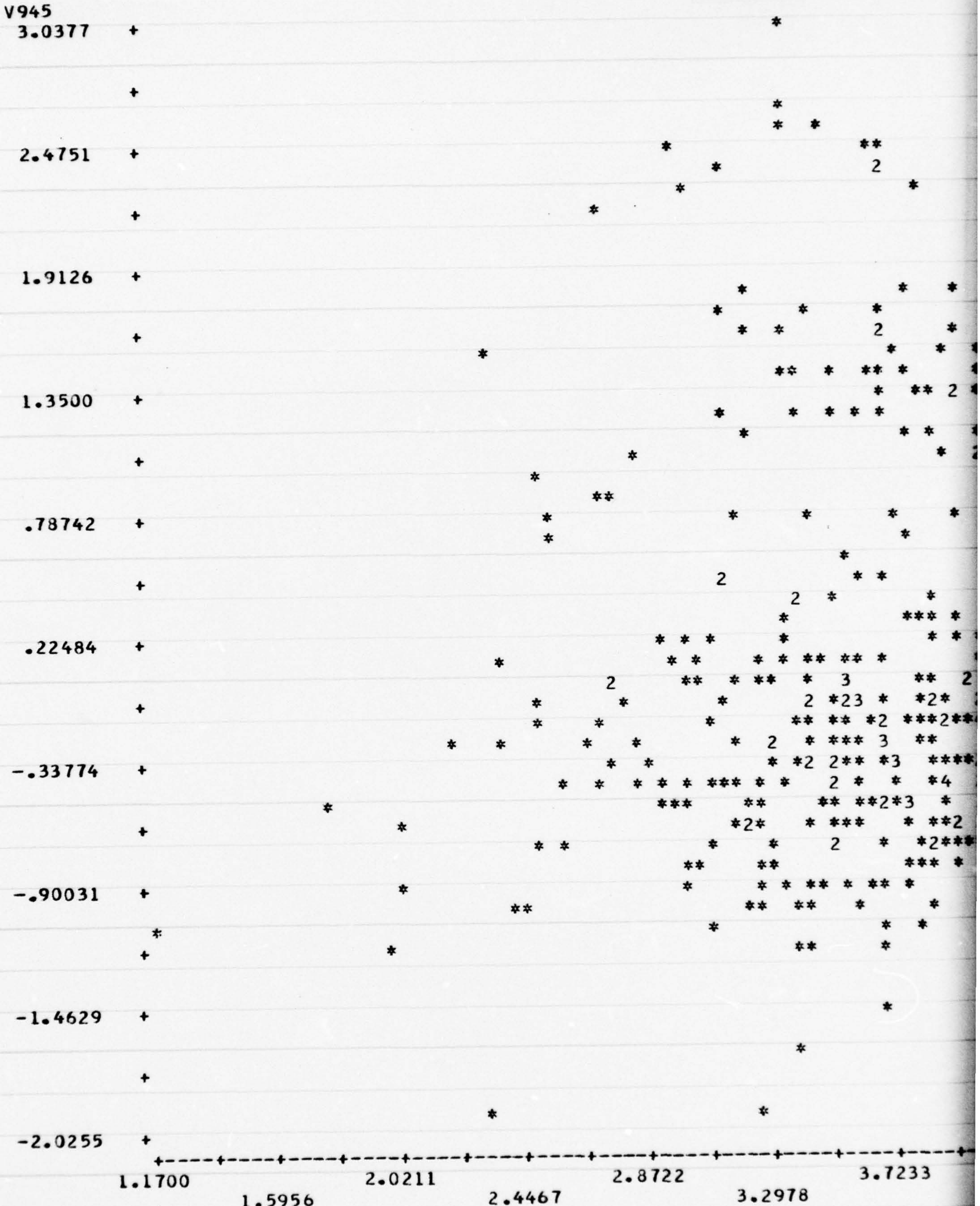

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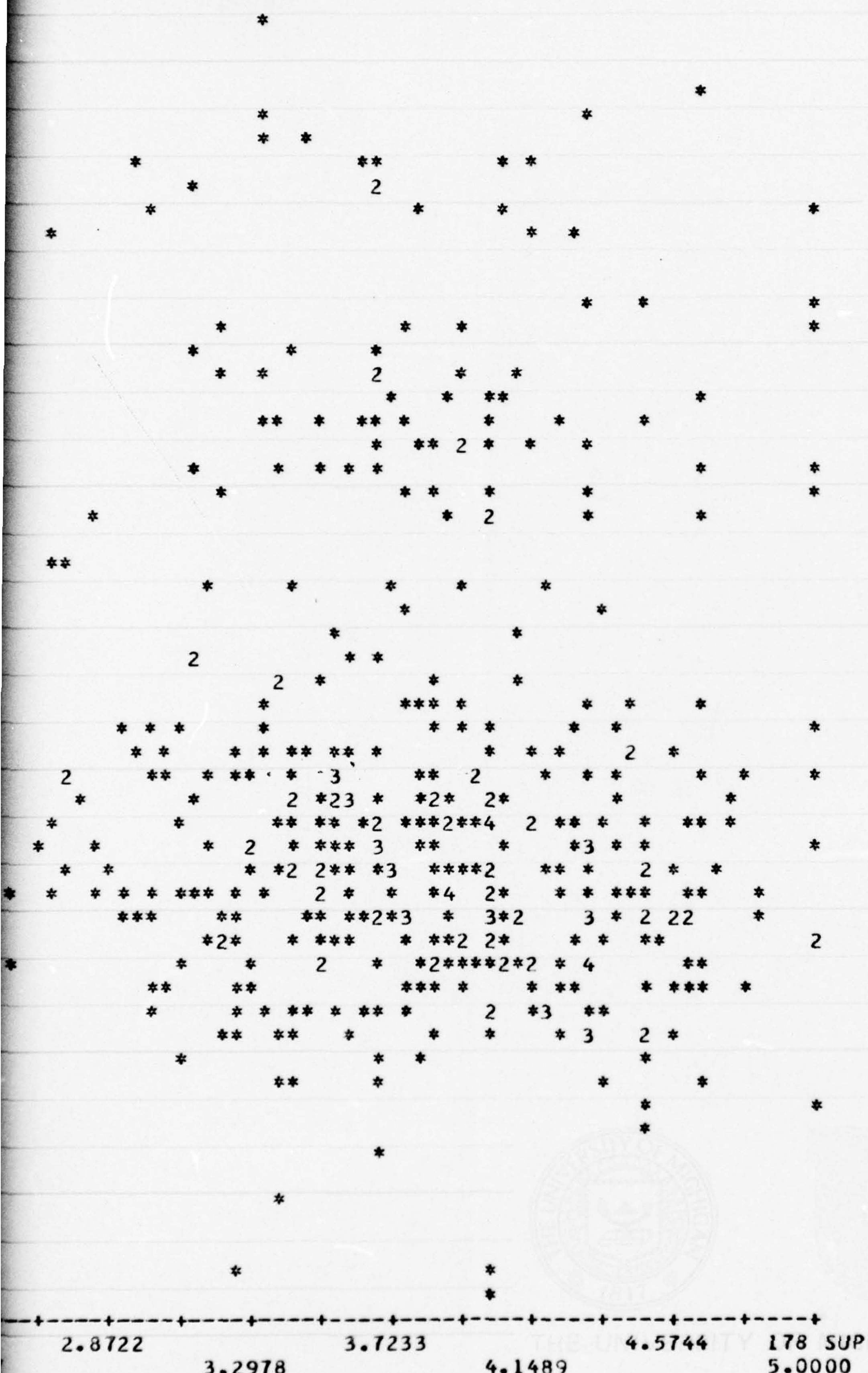

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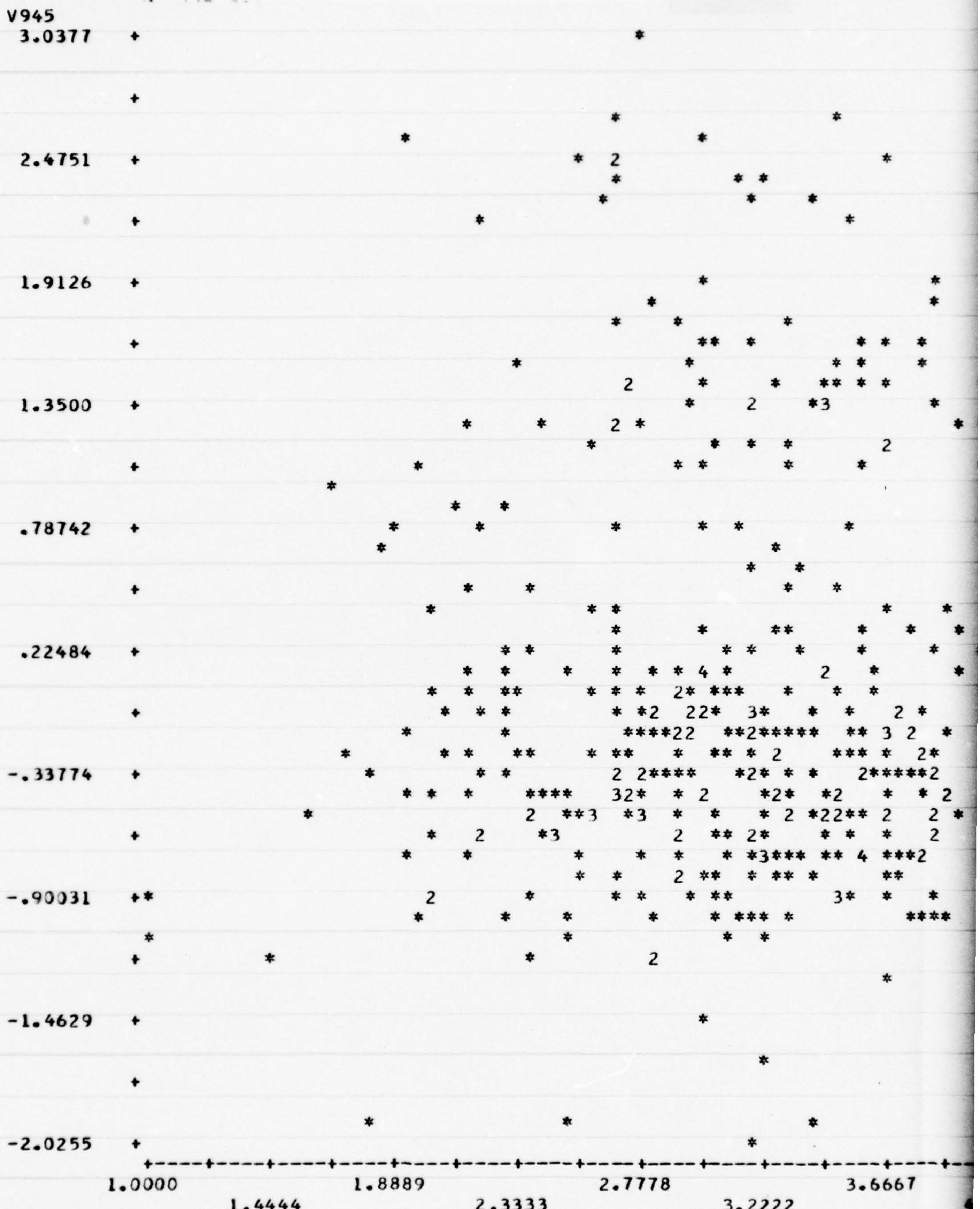

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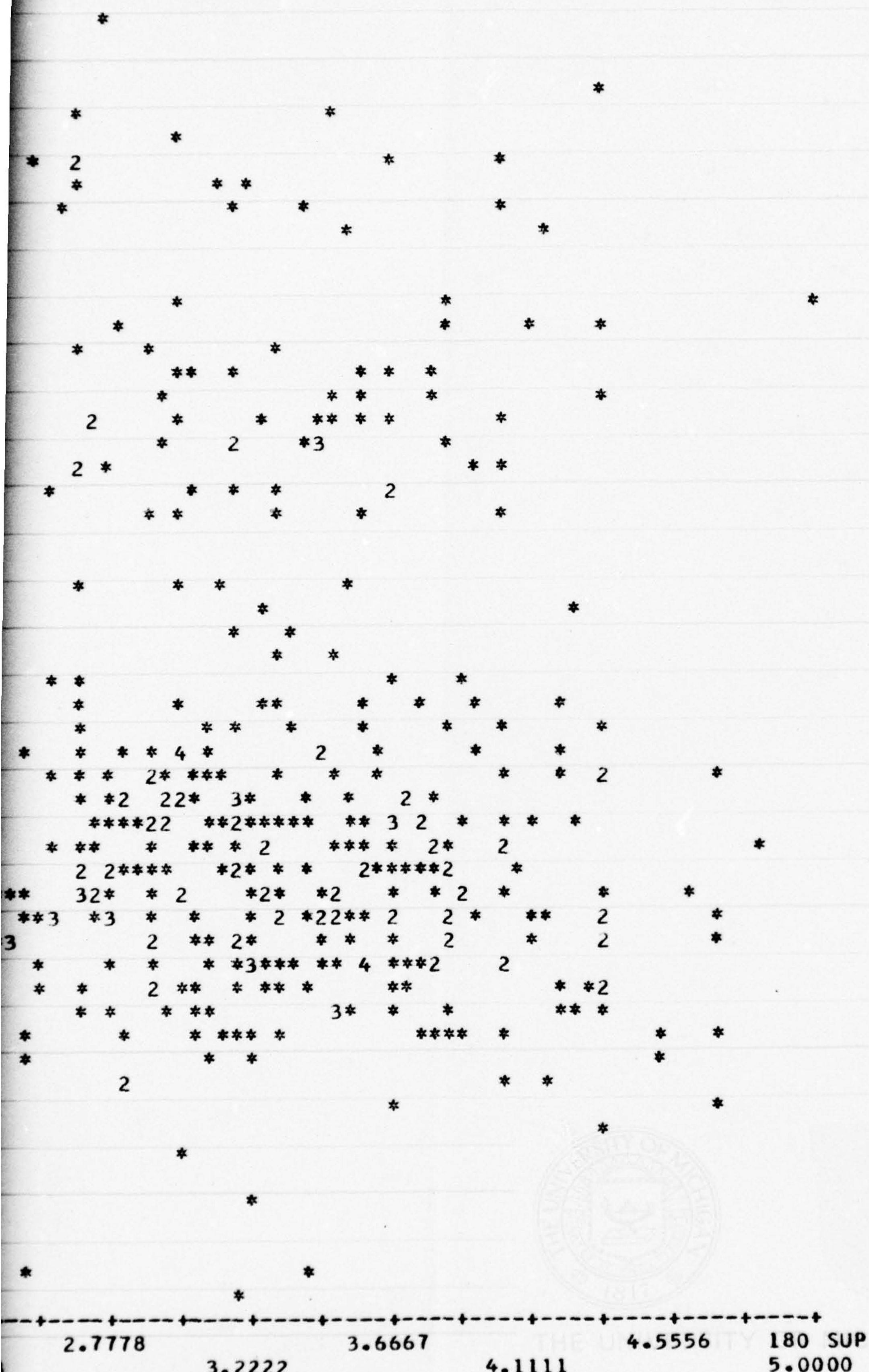

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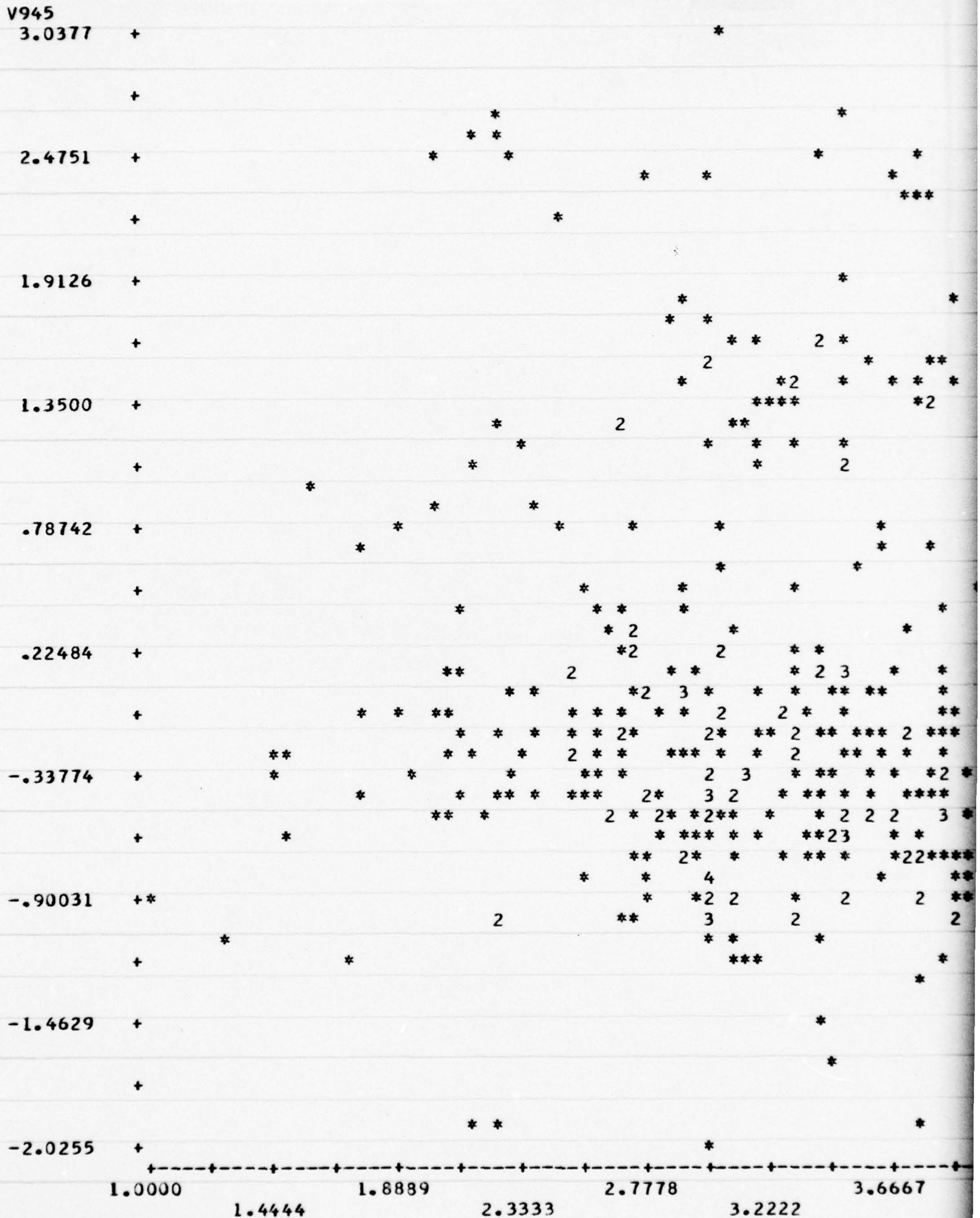

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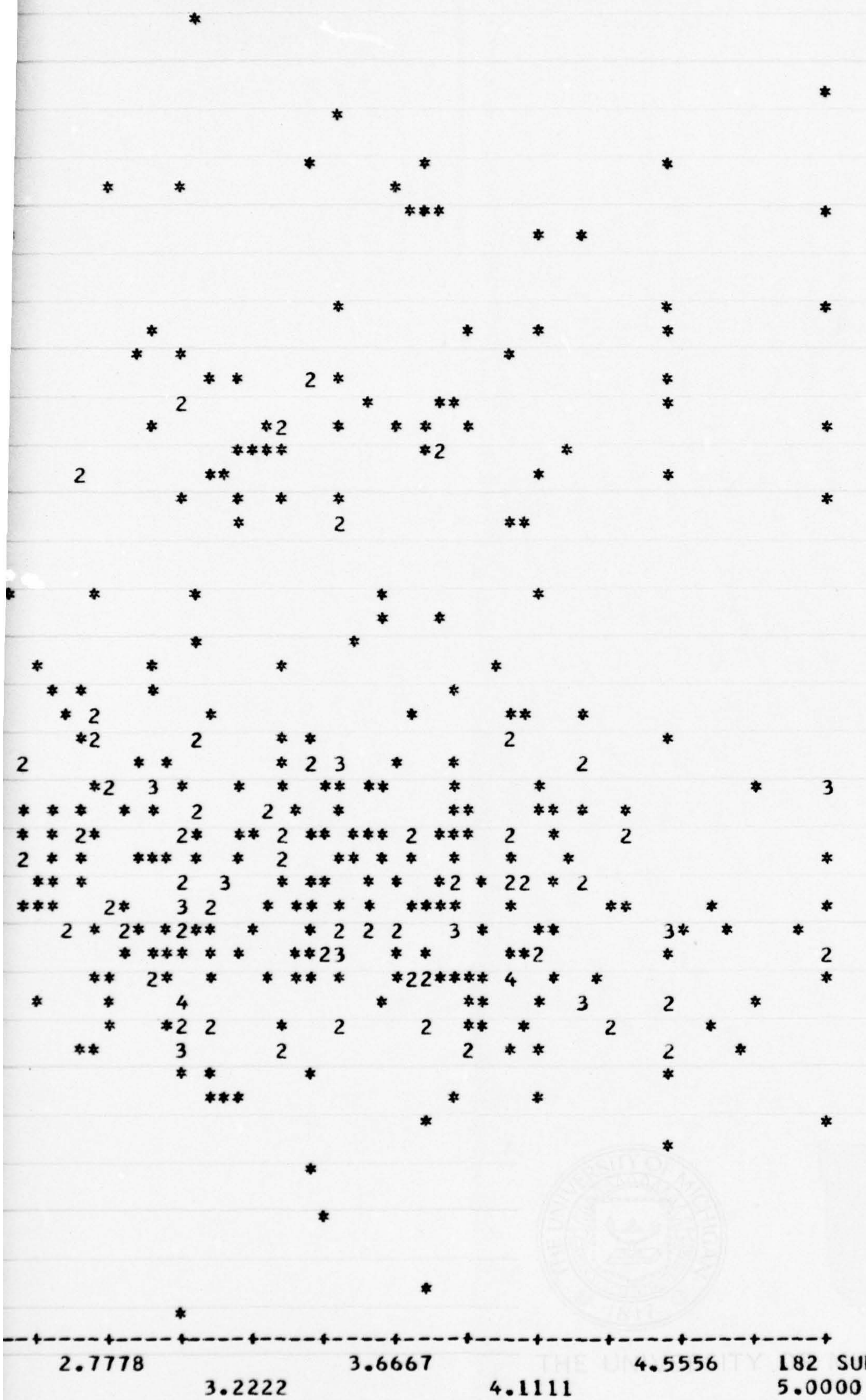

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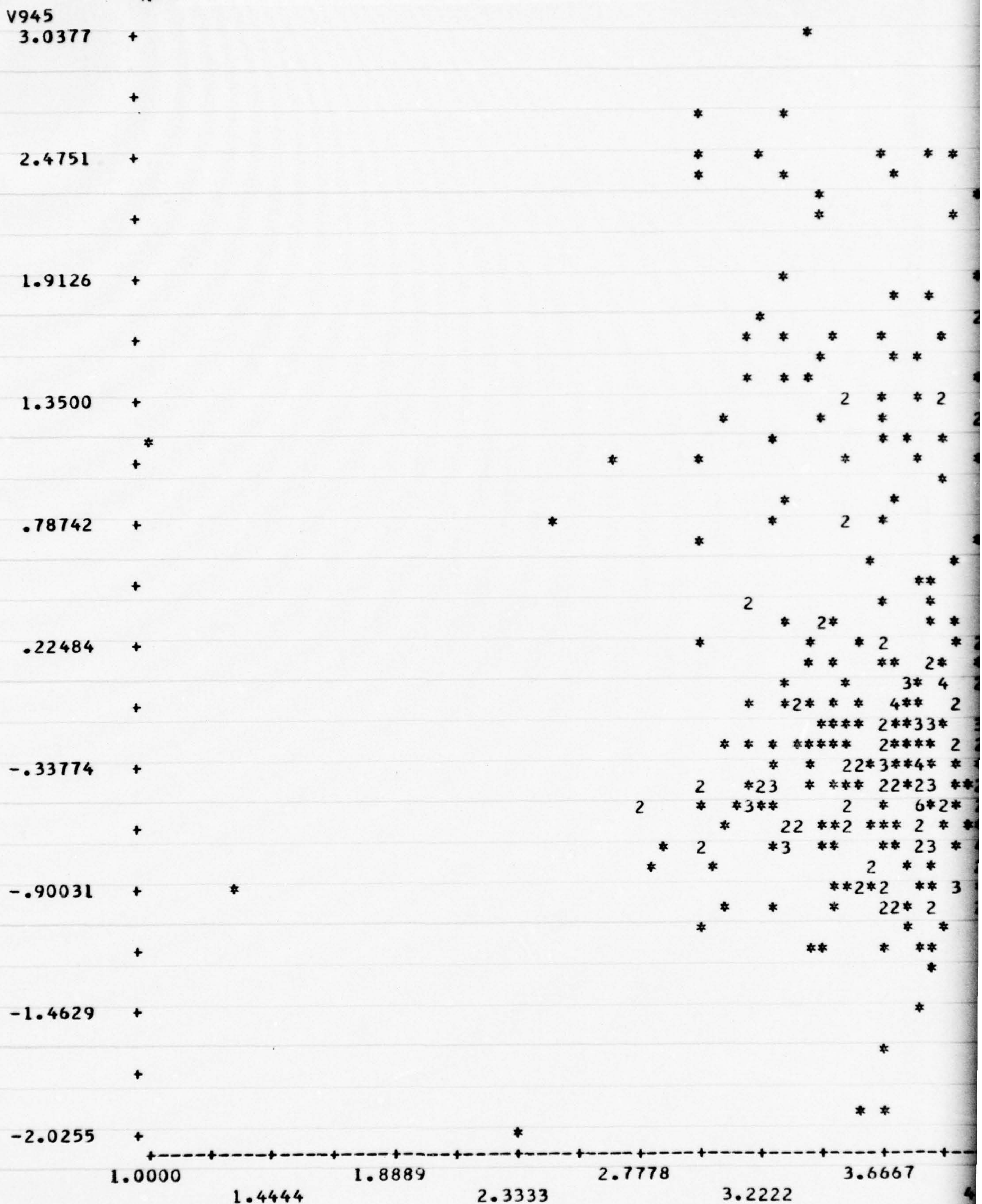

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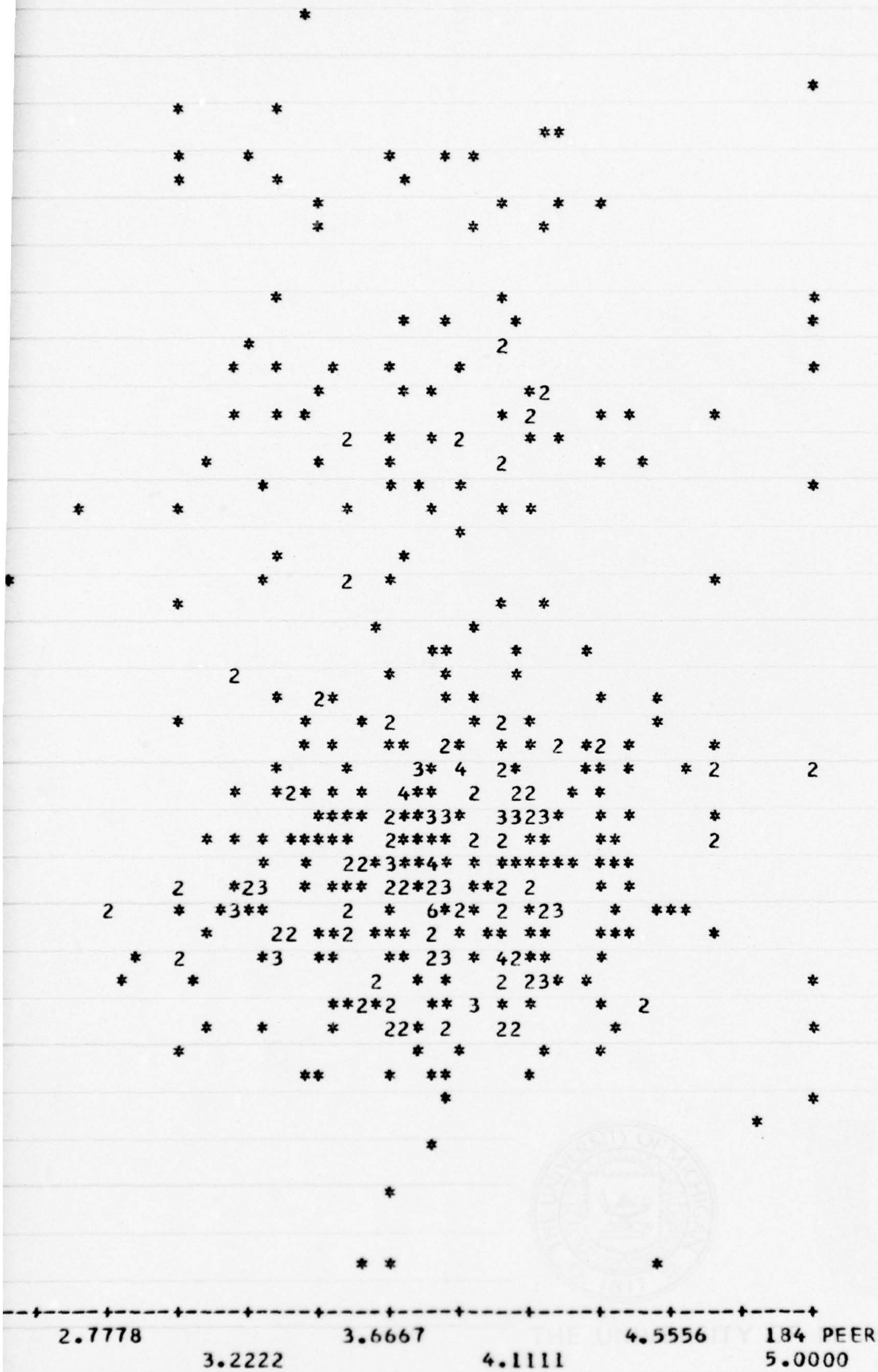

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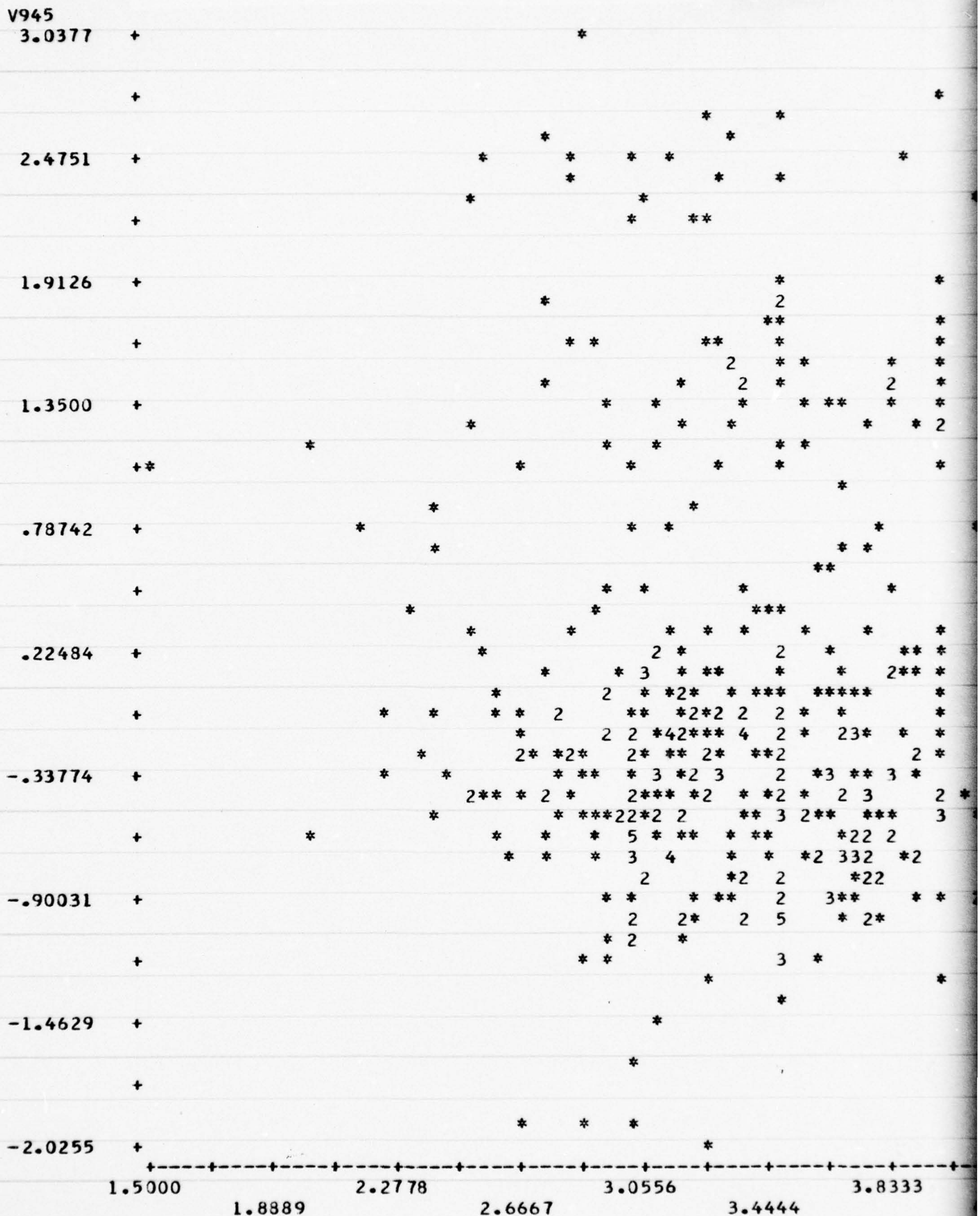

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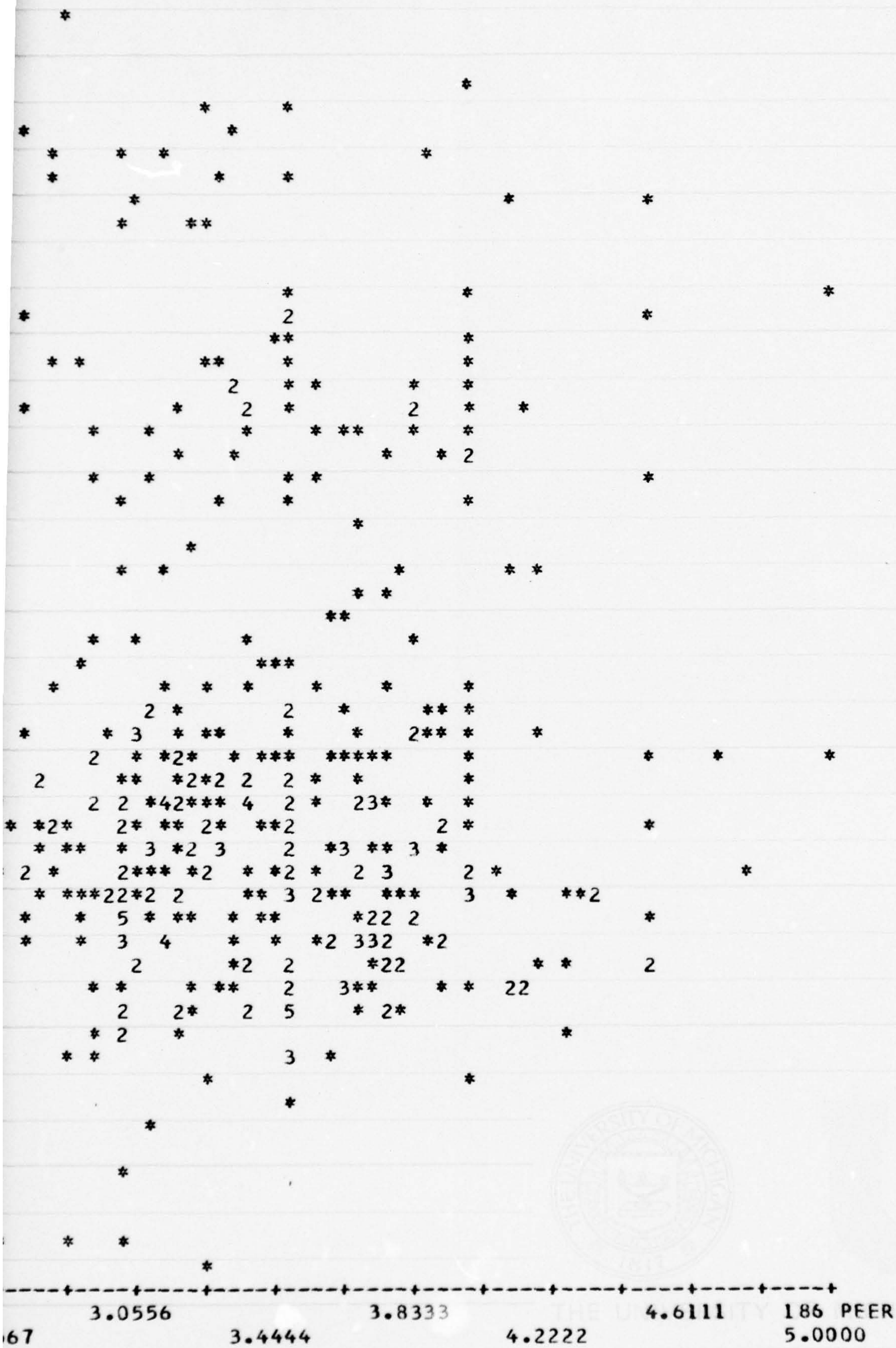

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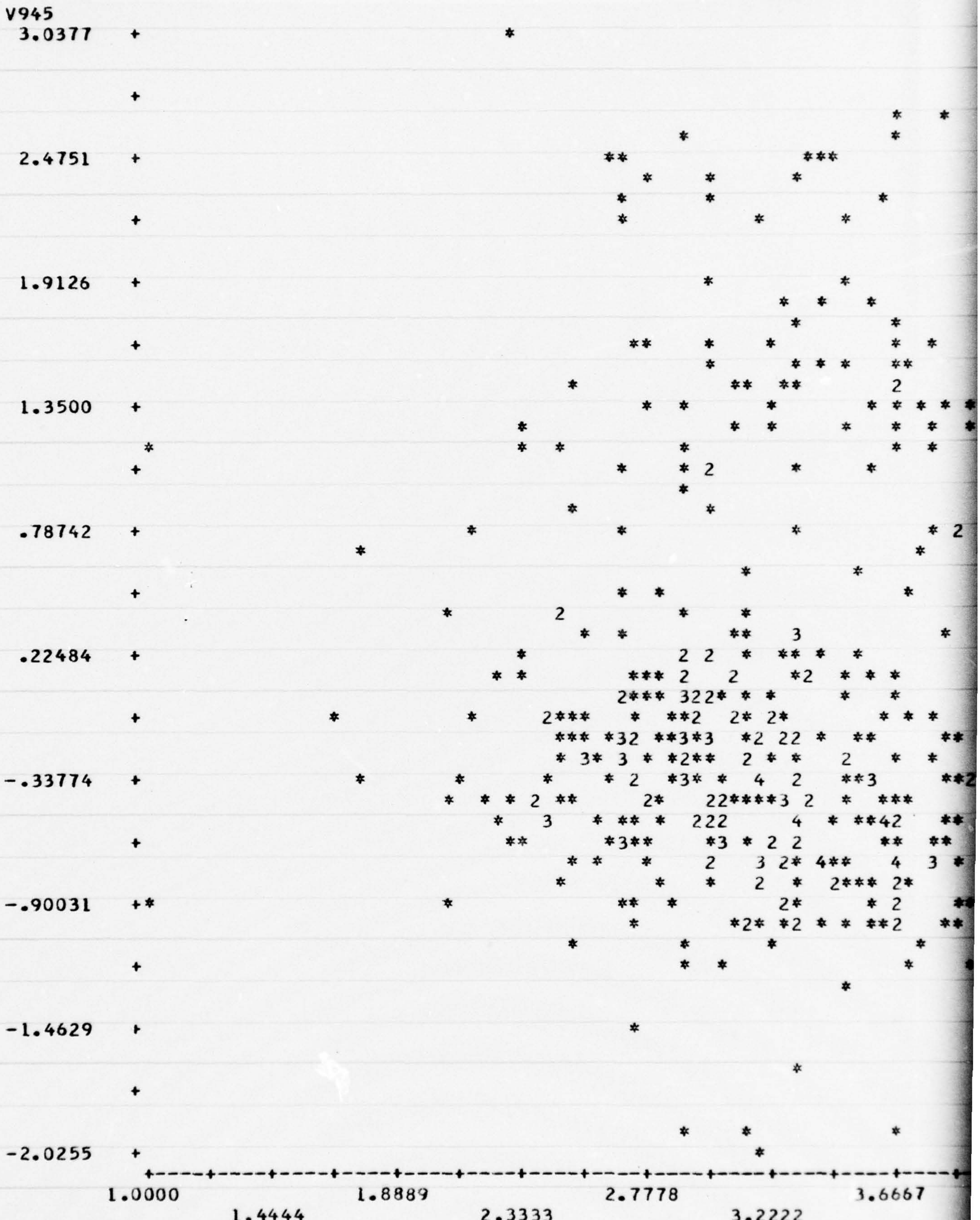

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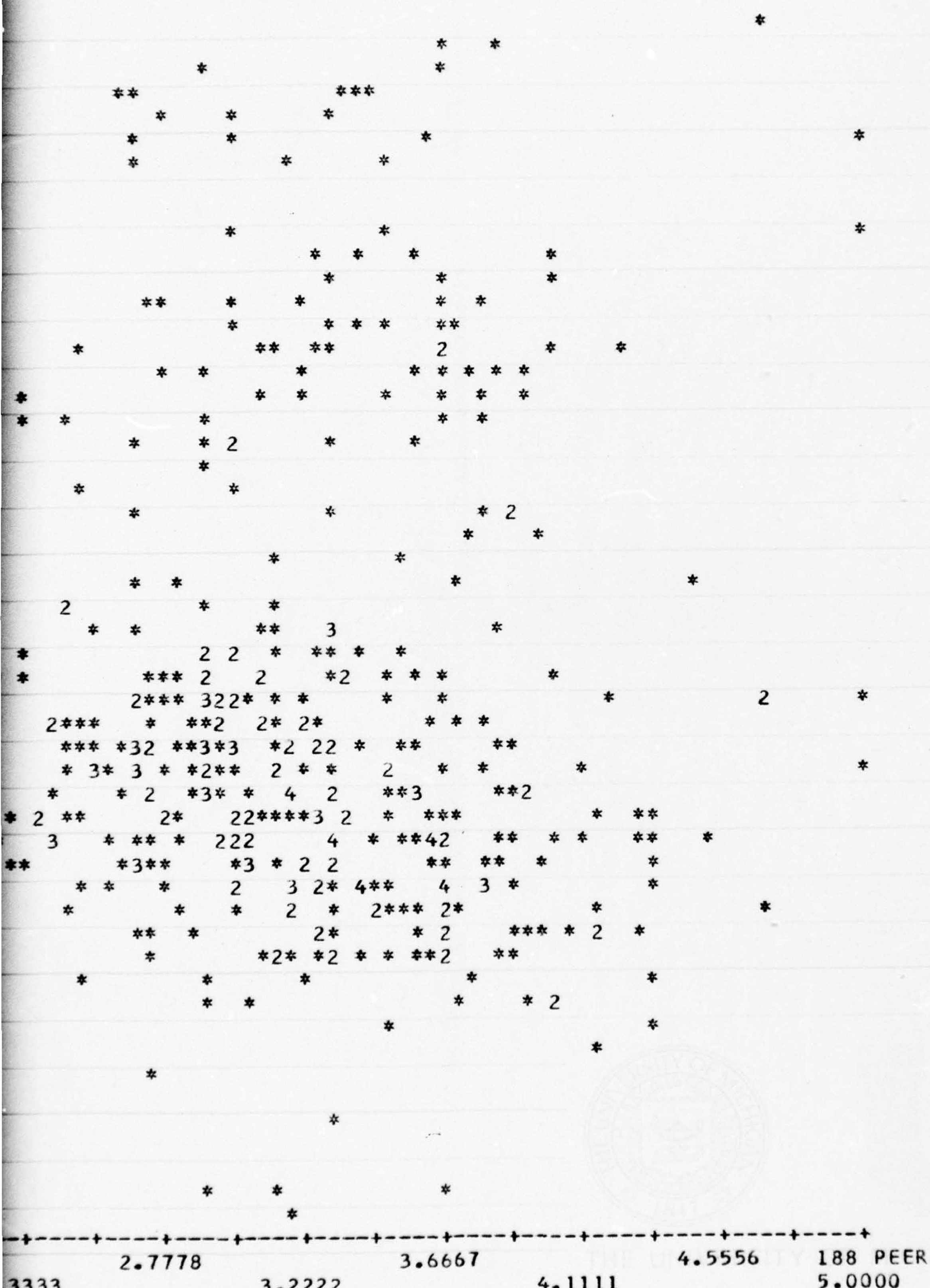

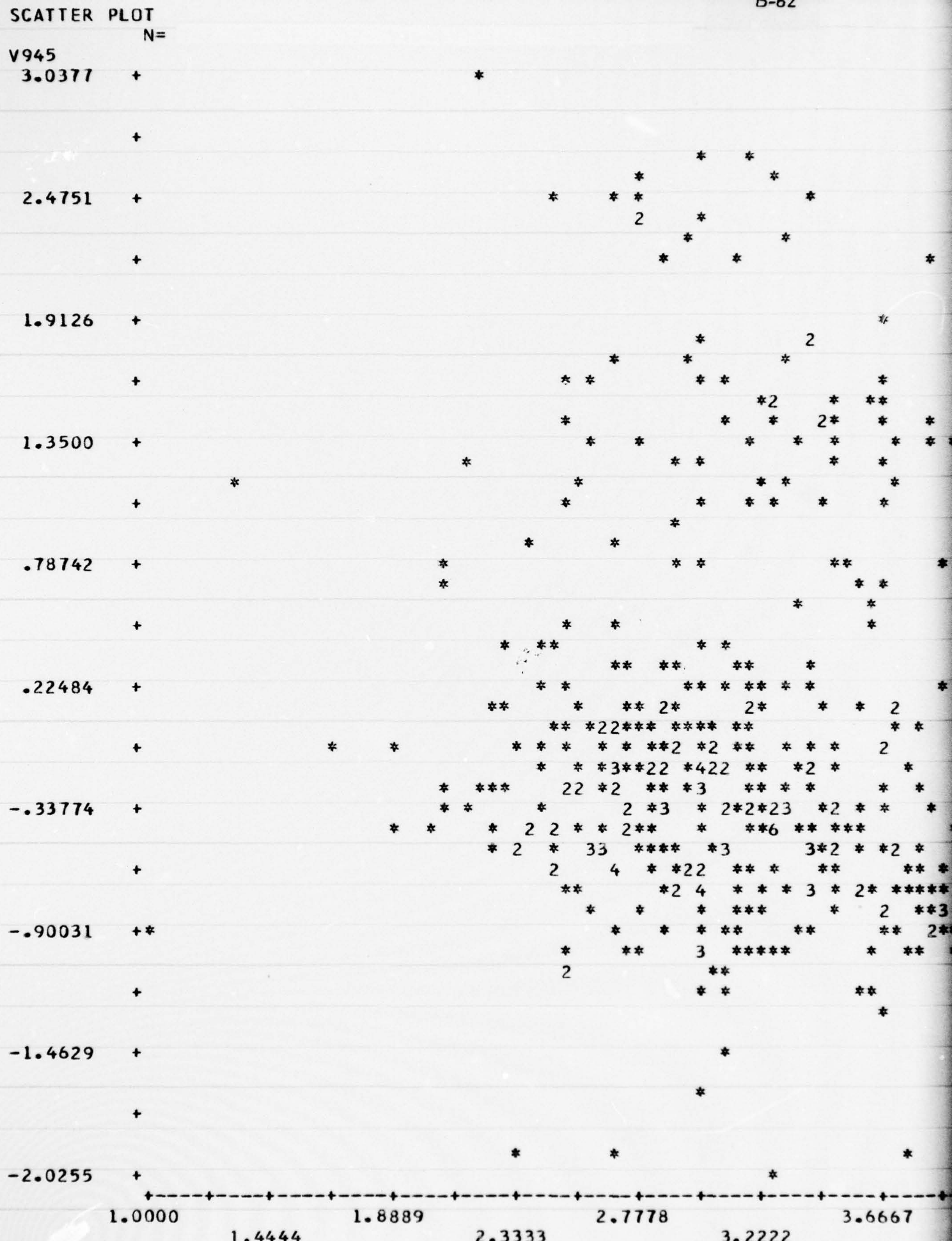
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B-62

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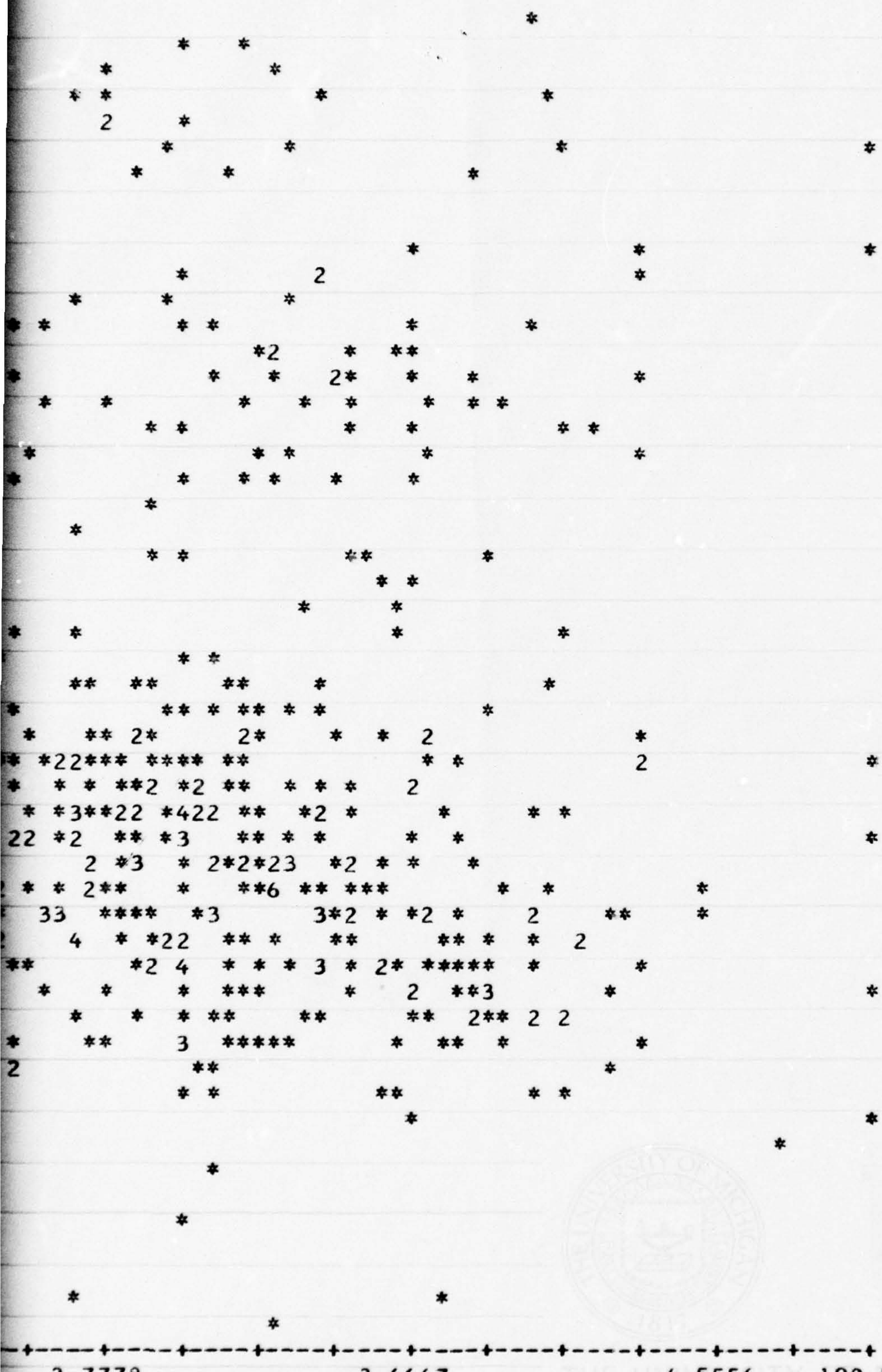

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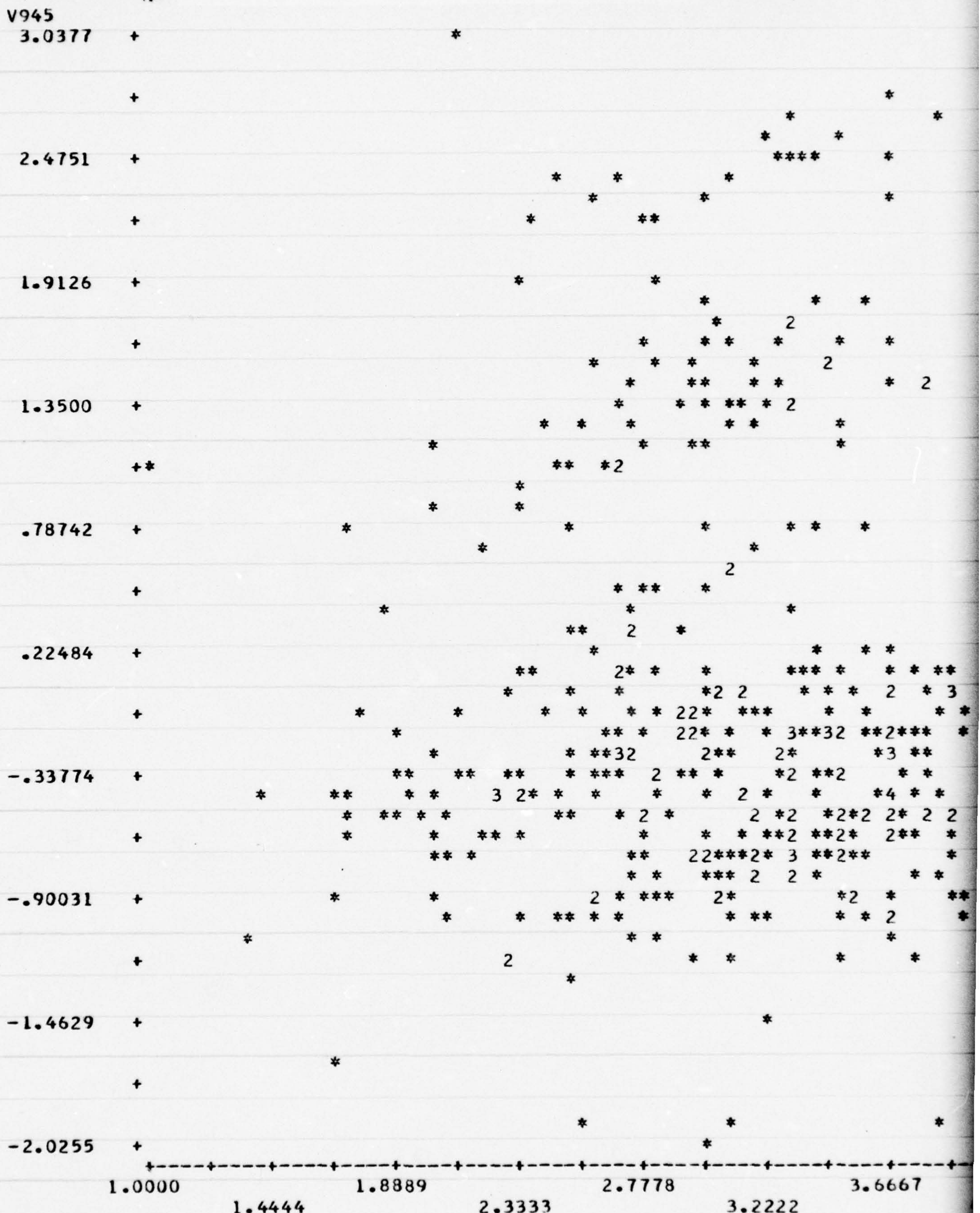

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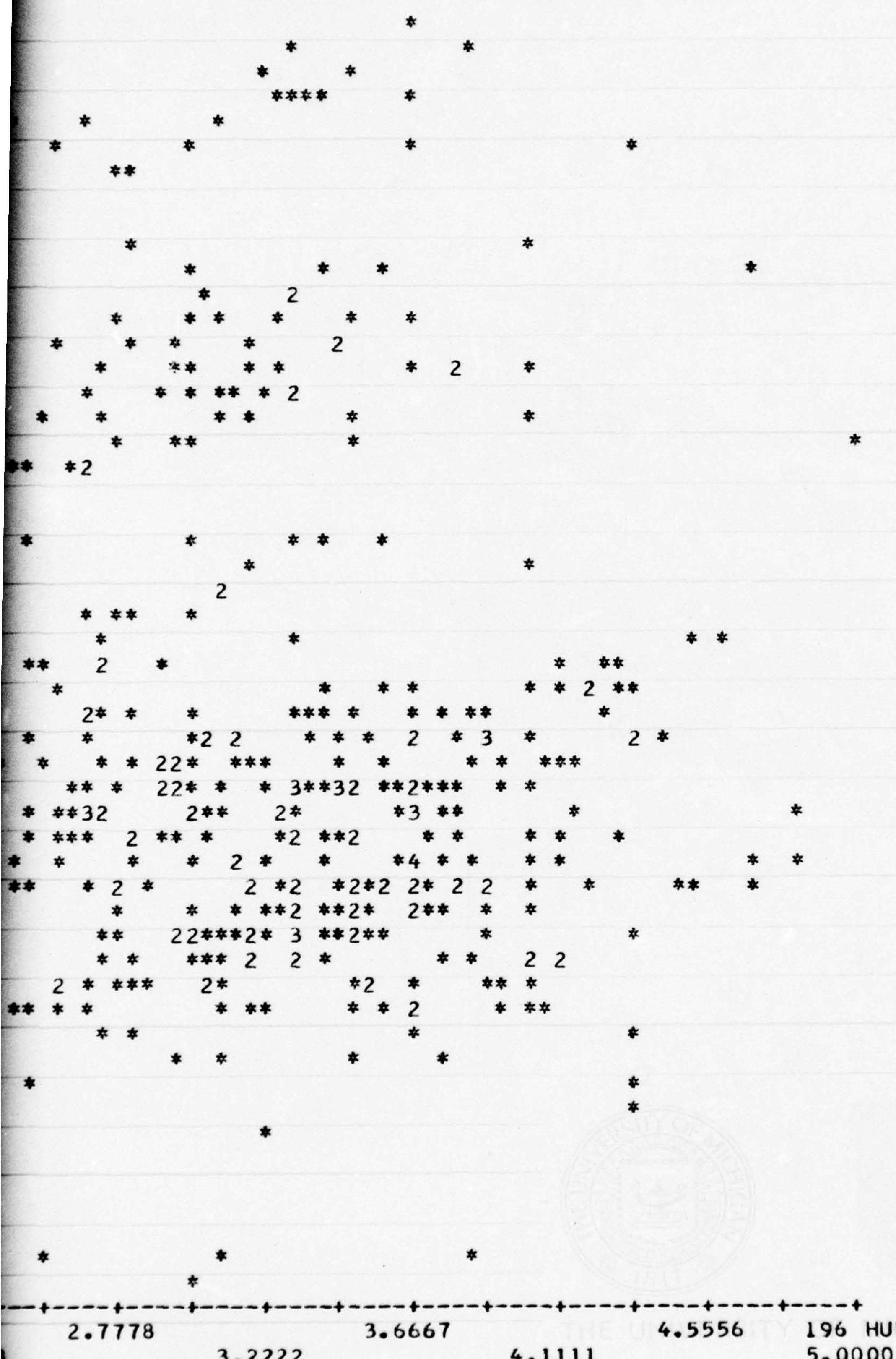

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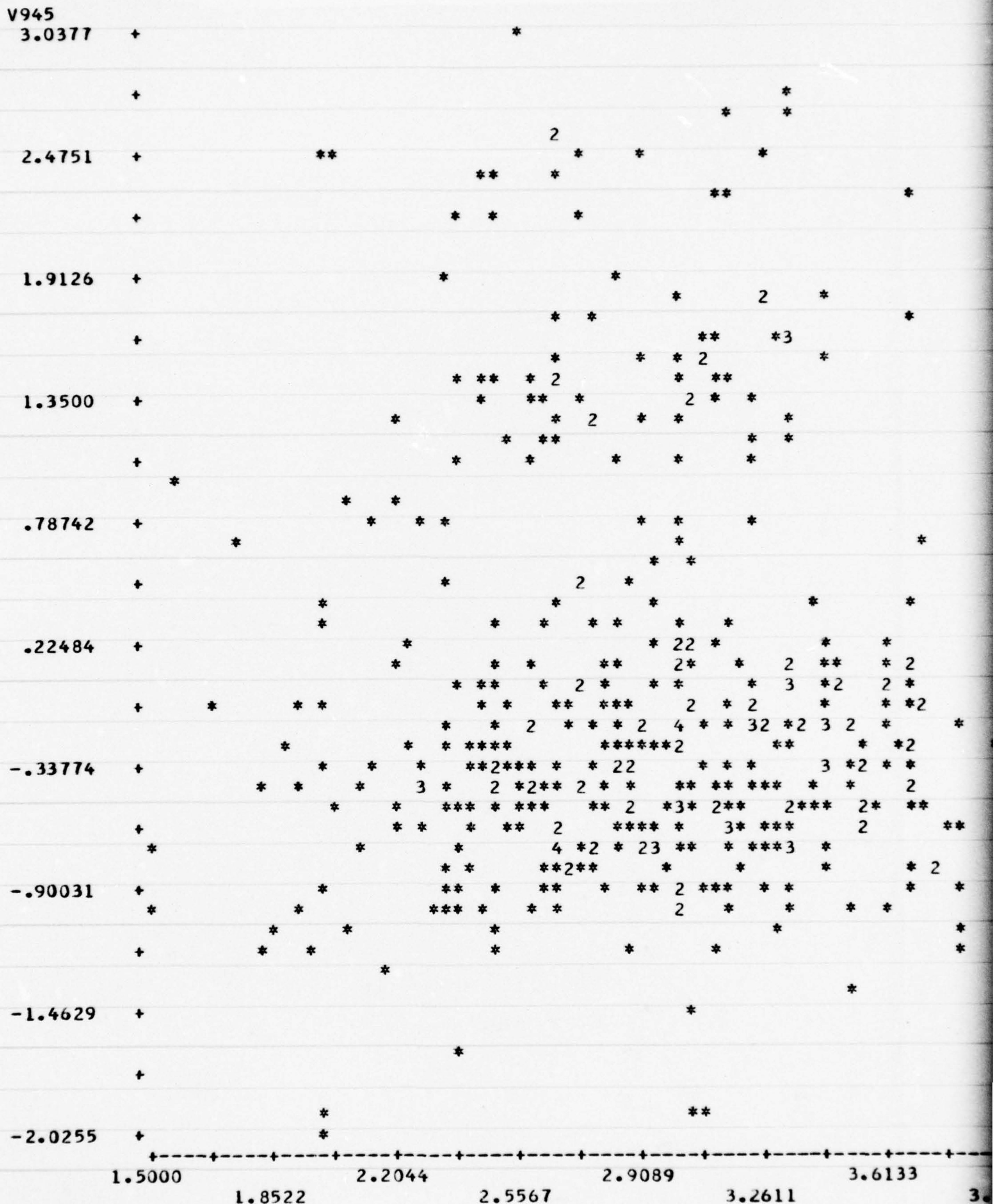

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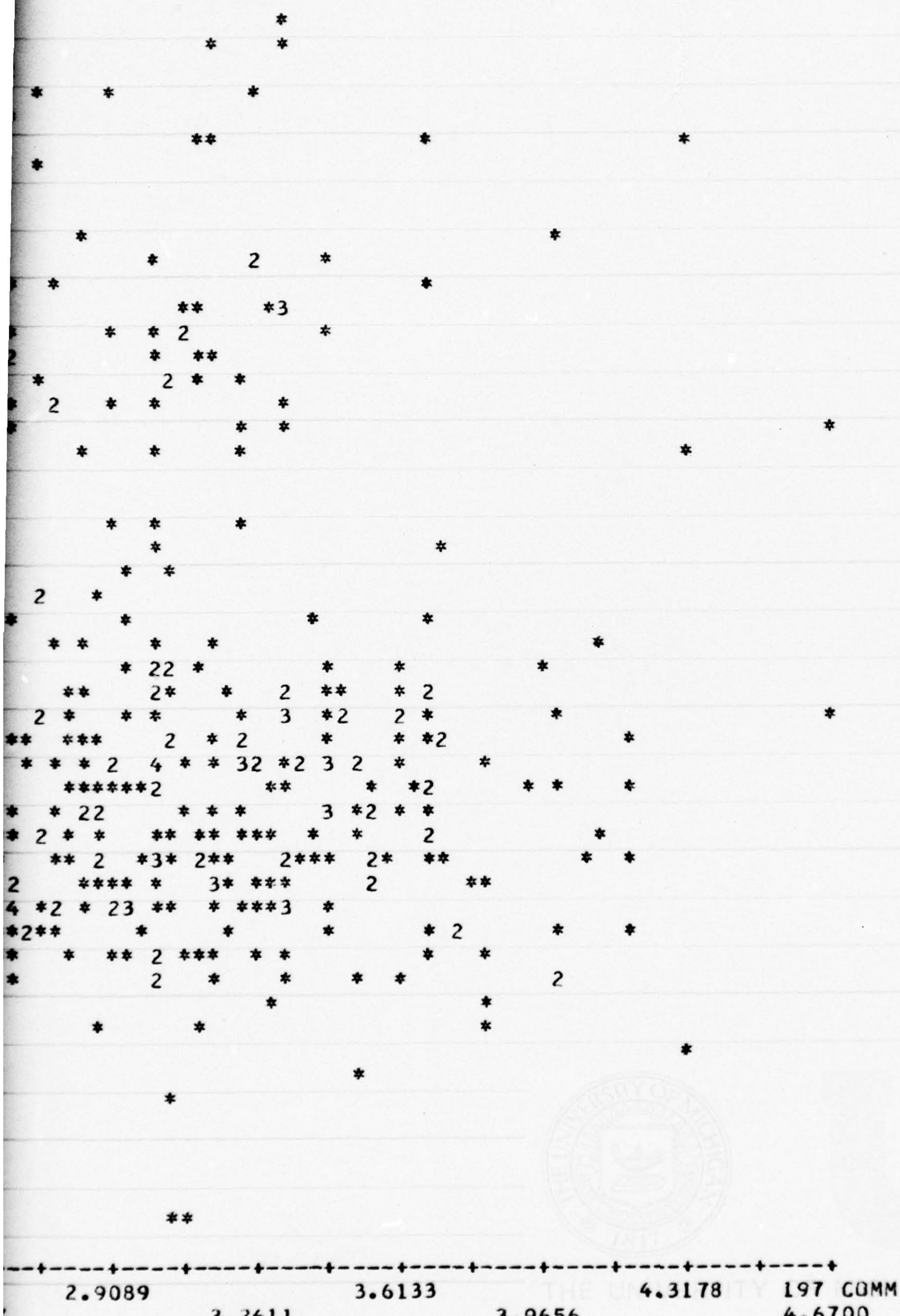

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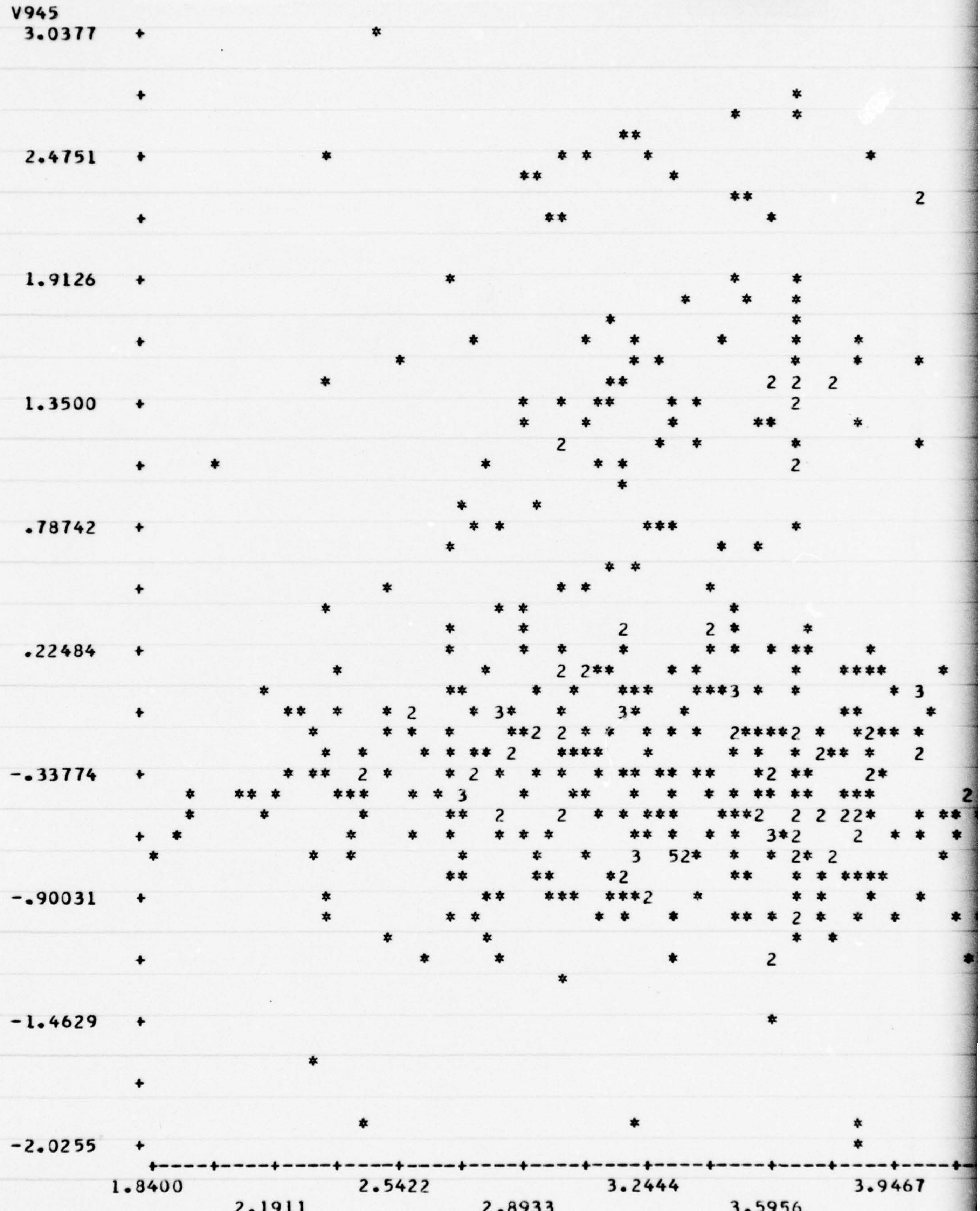

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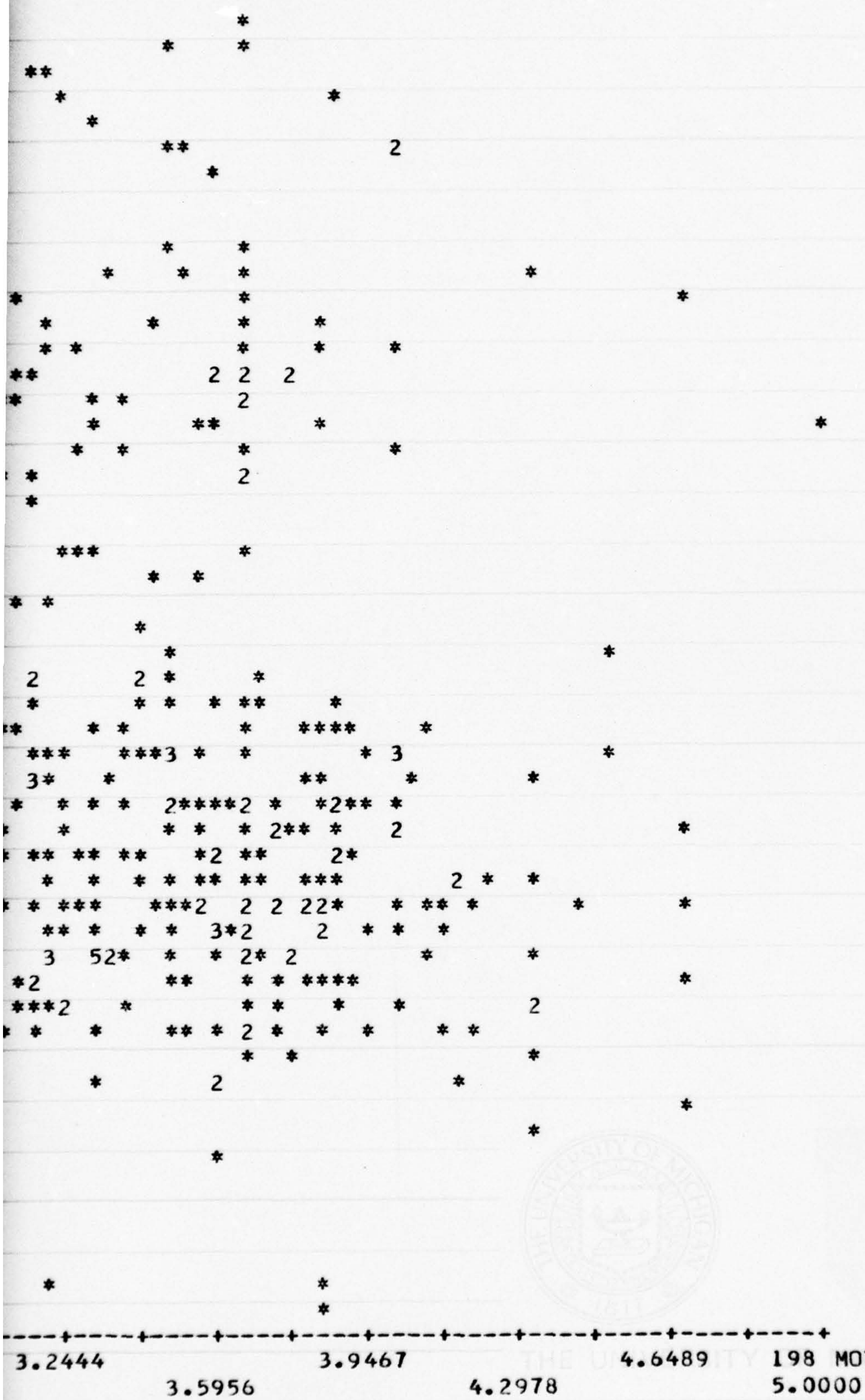

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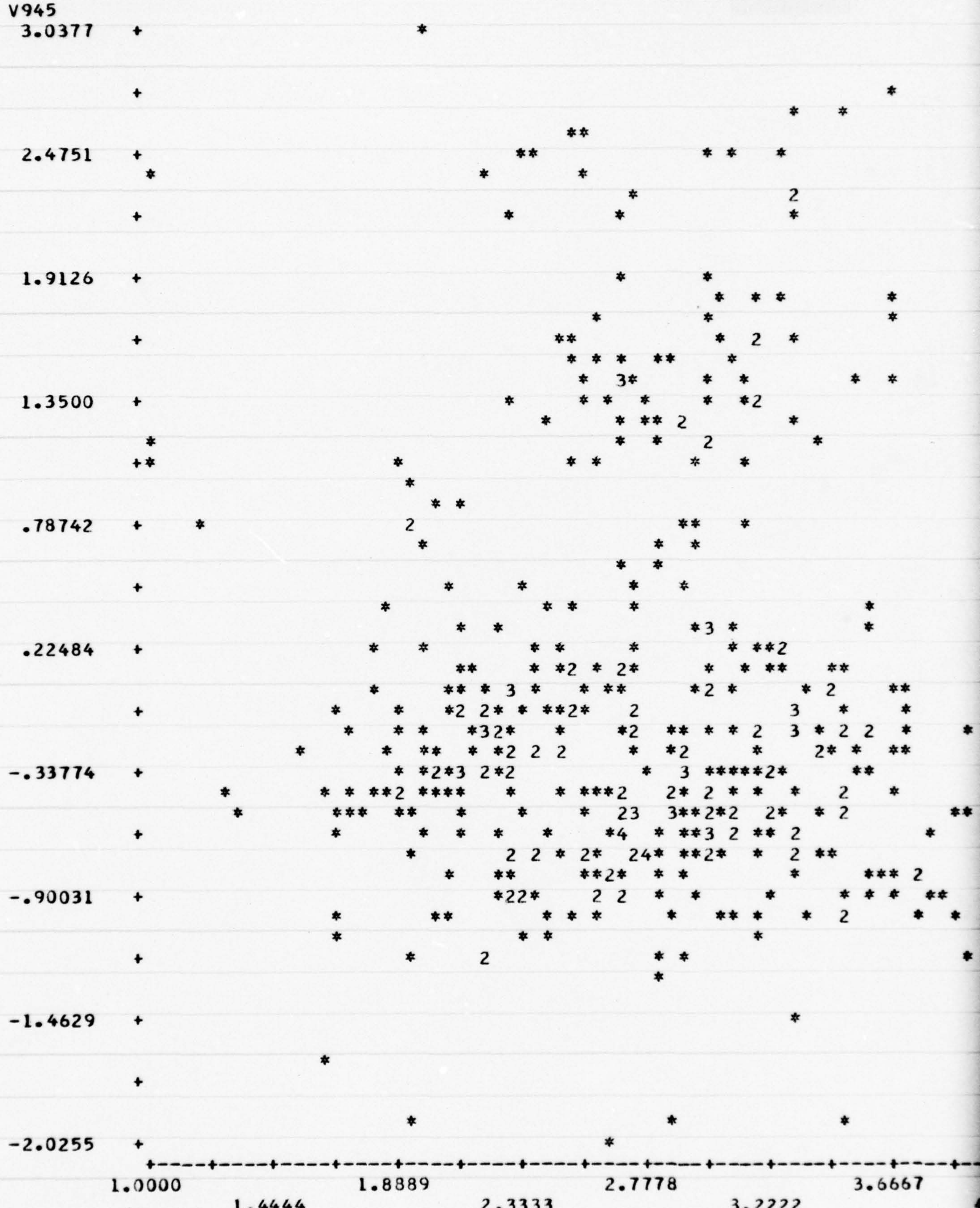

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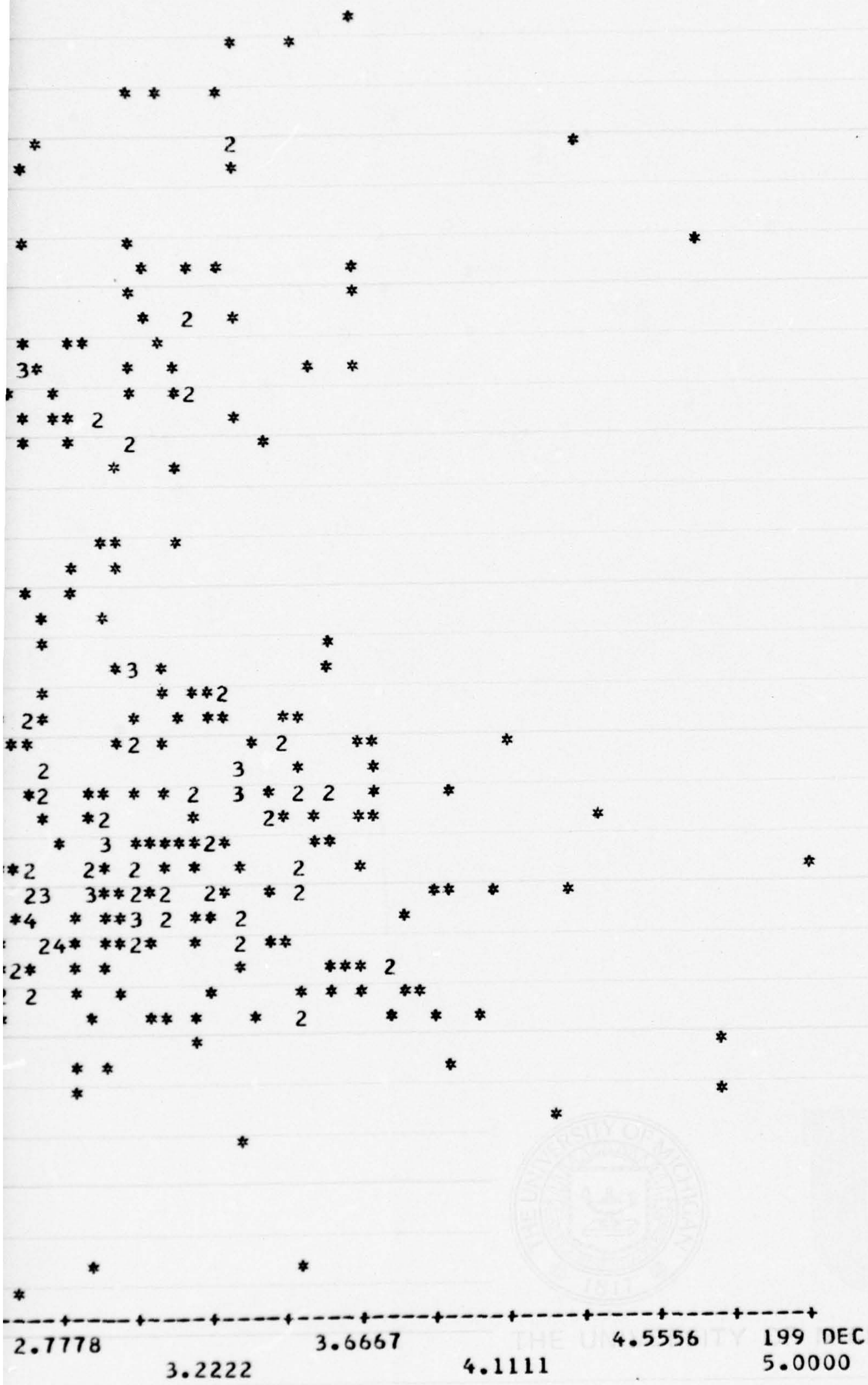

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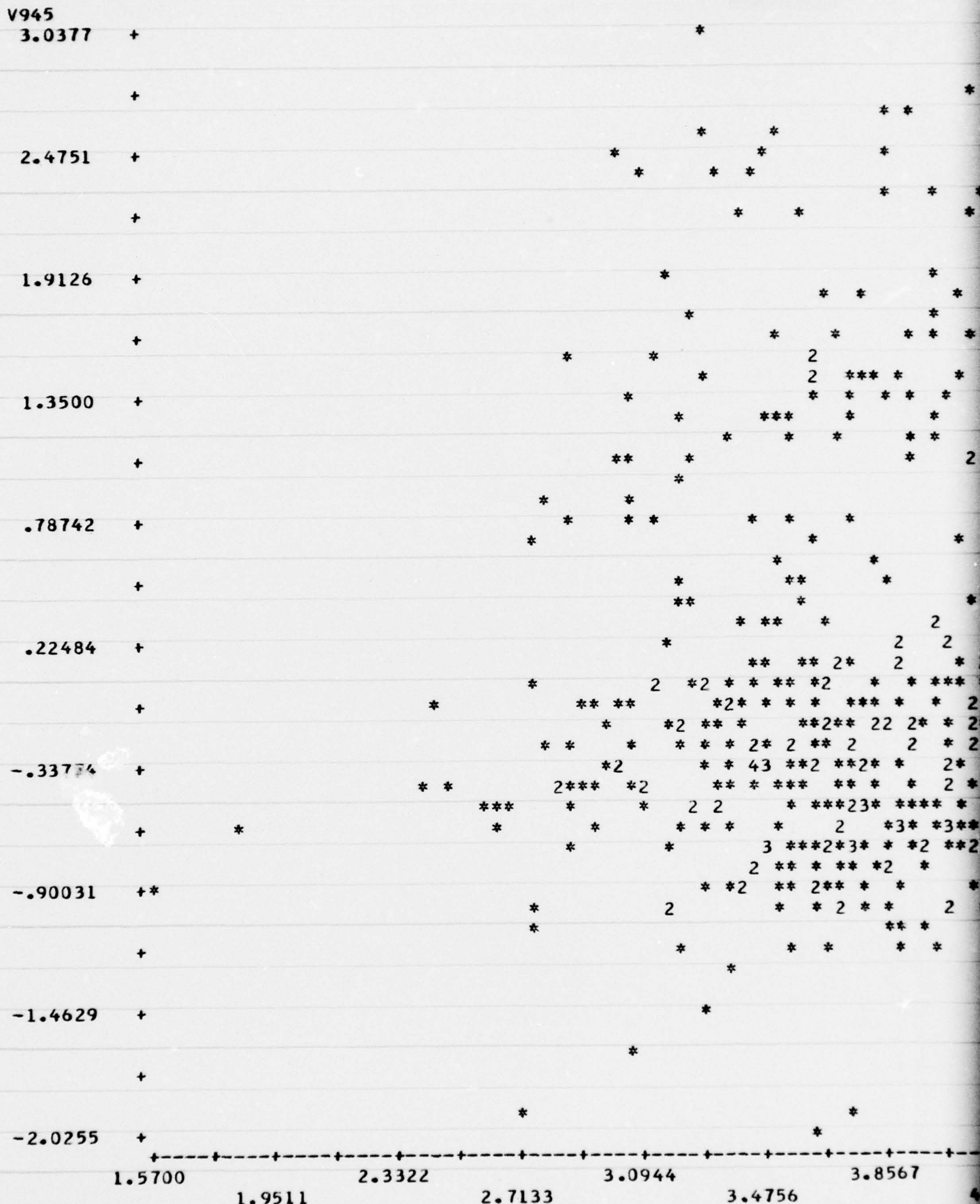

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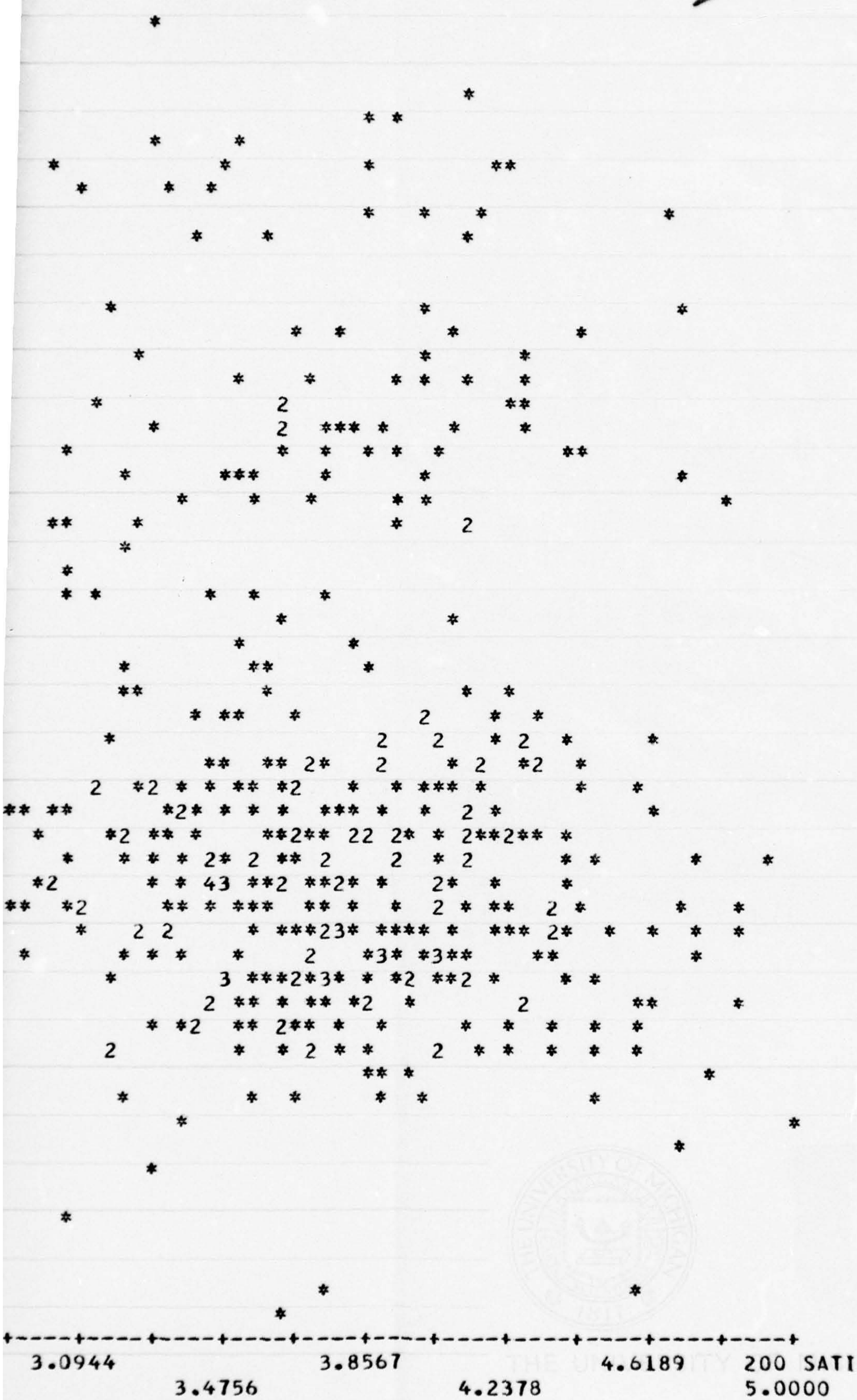

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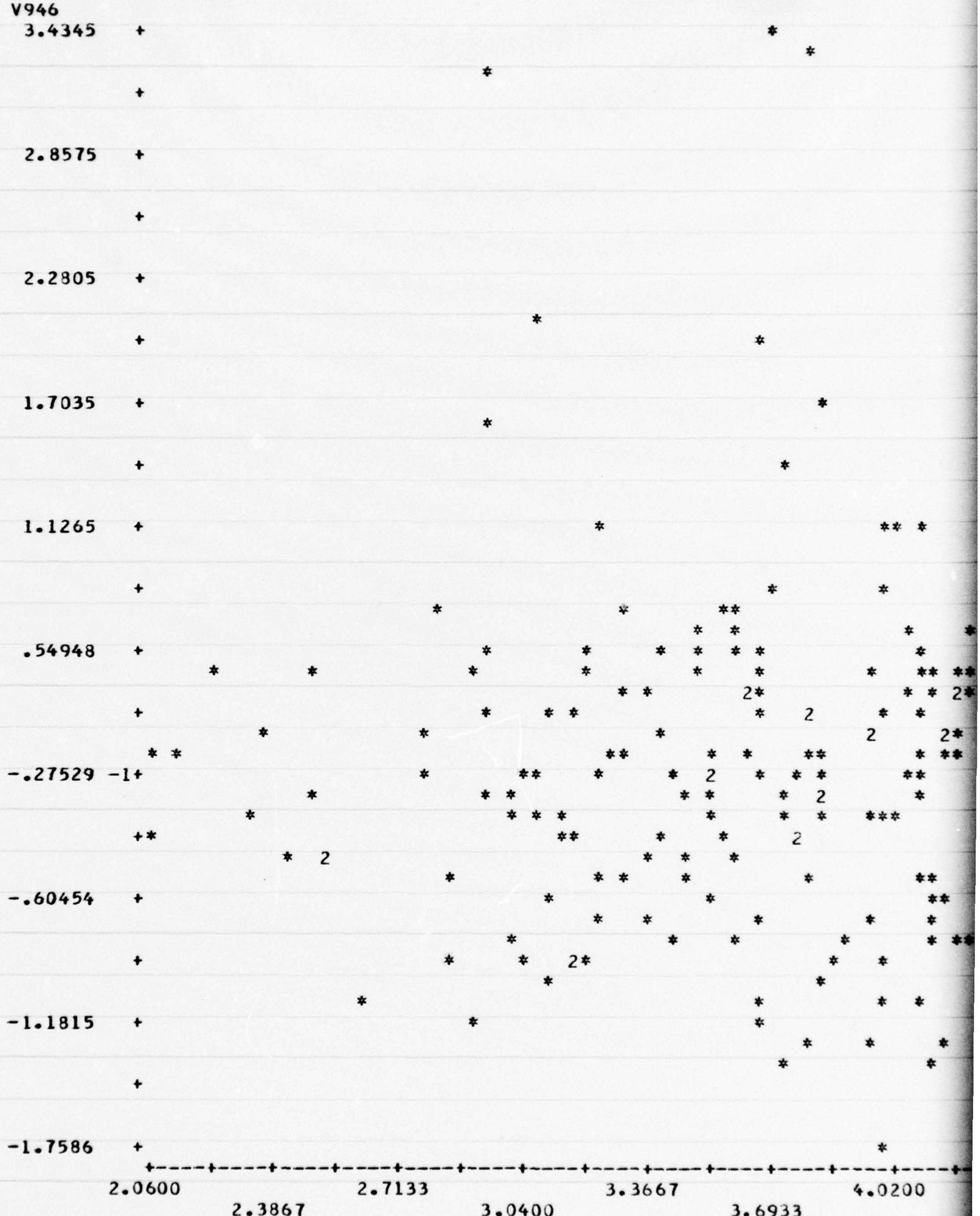

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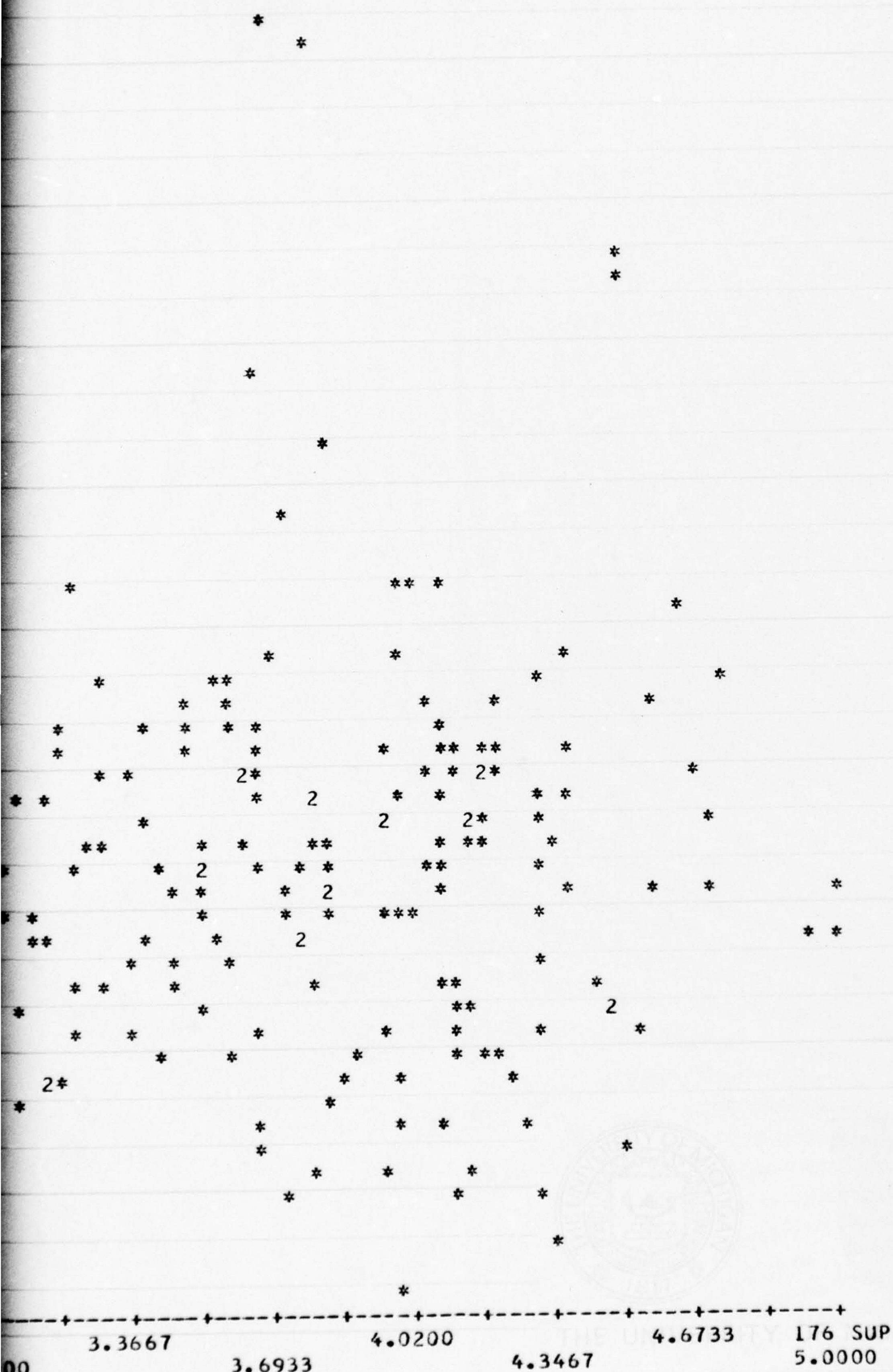

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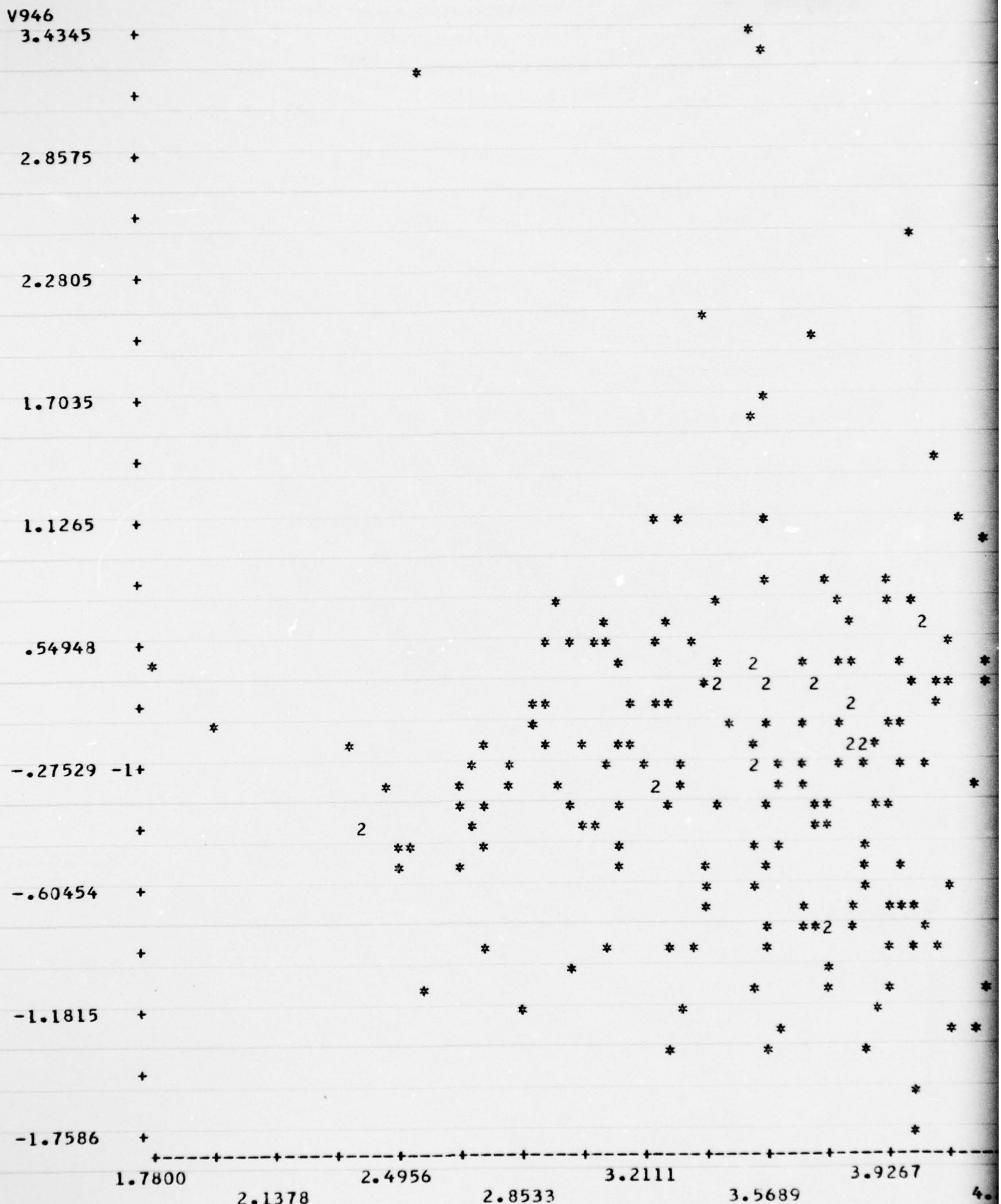

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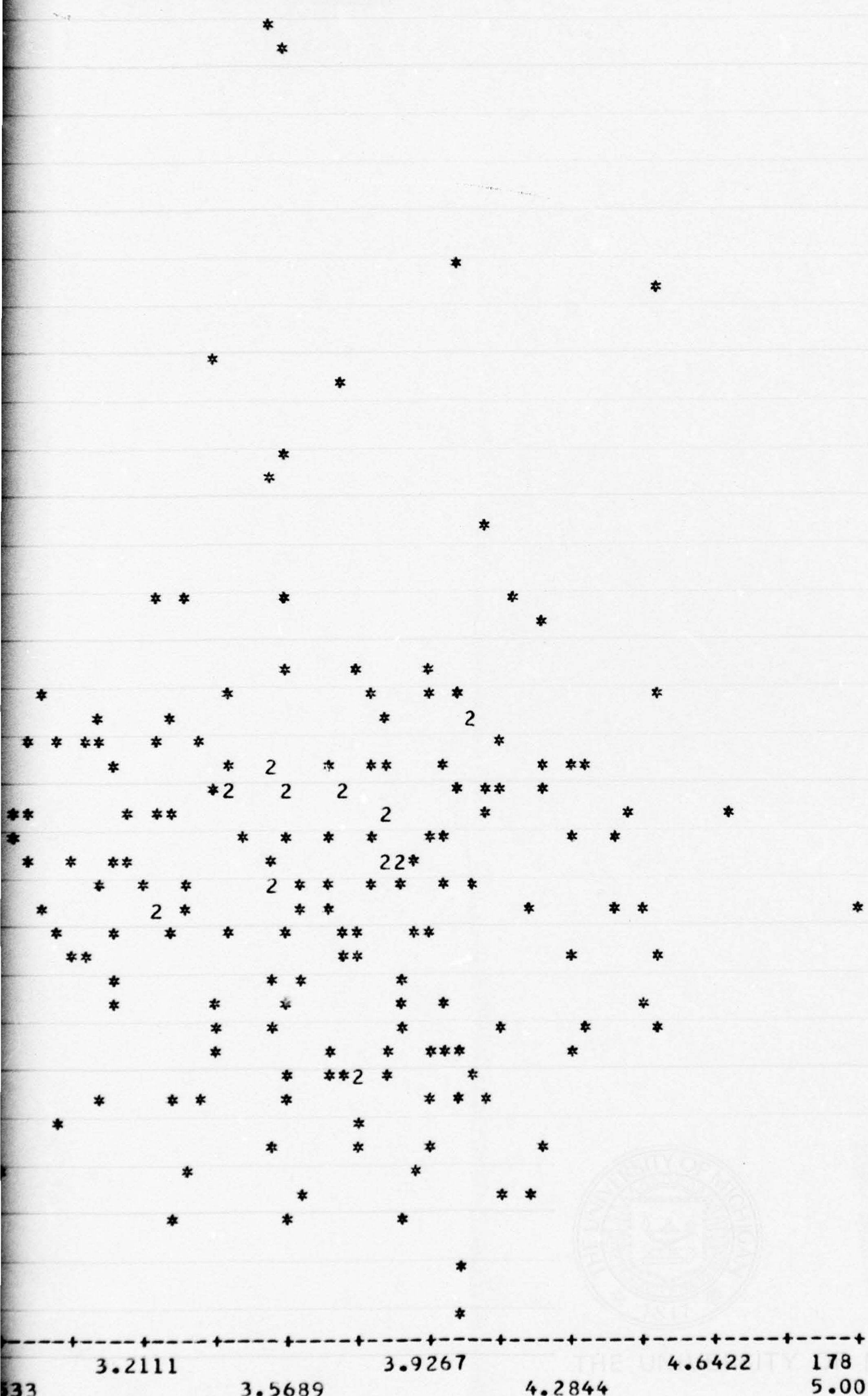

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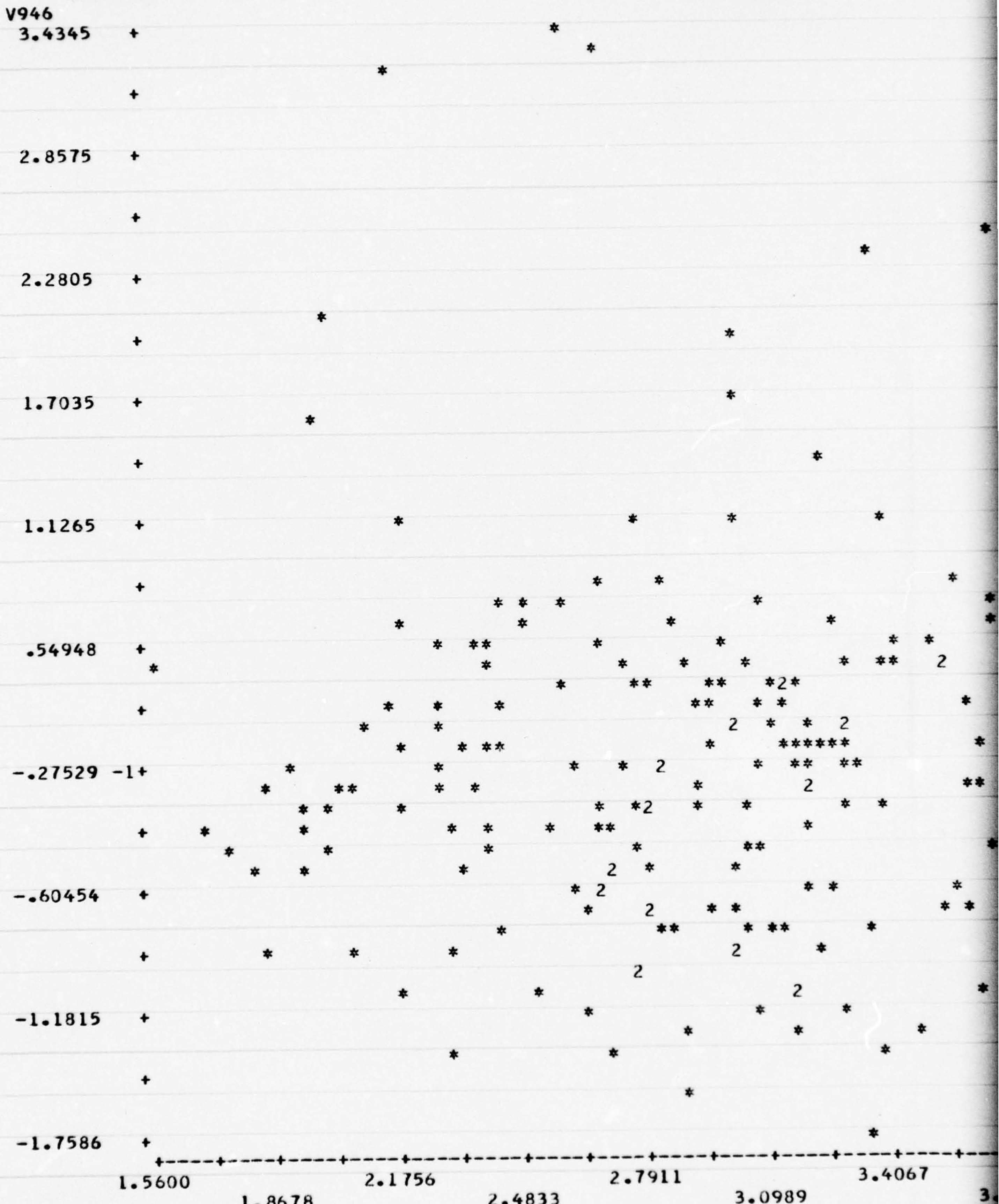

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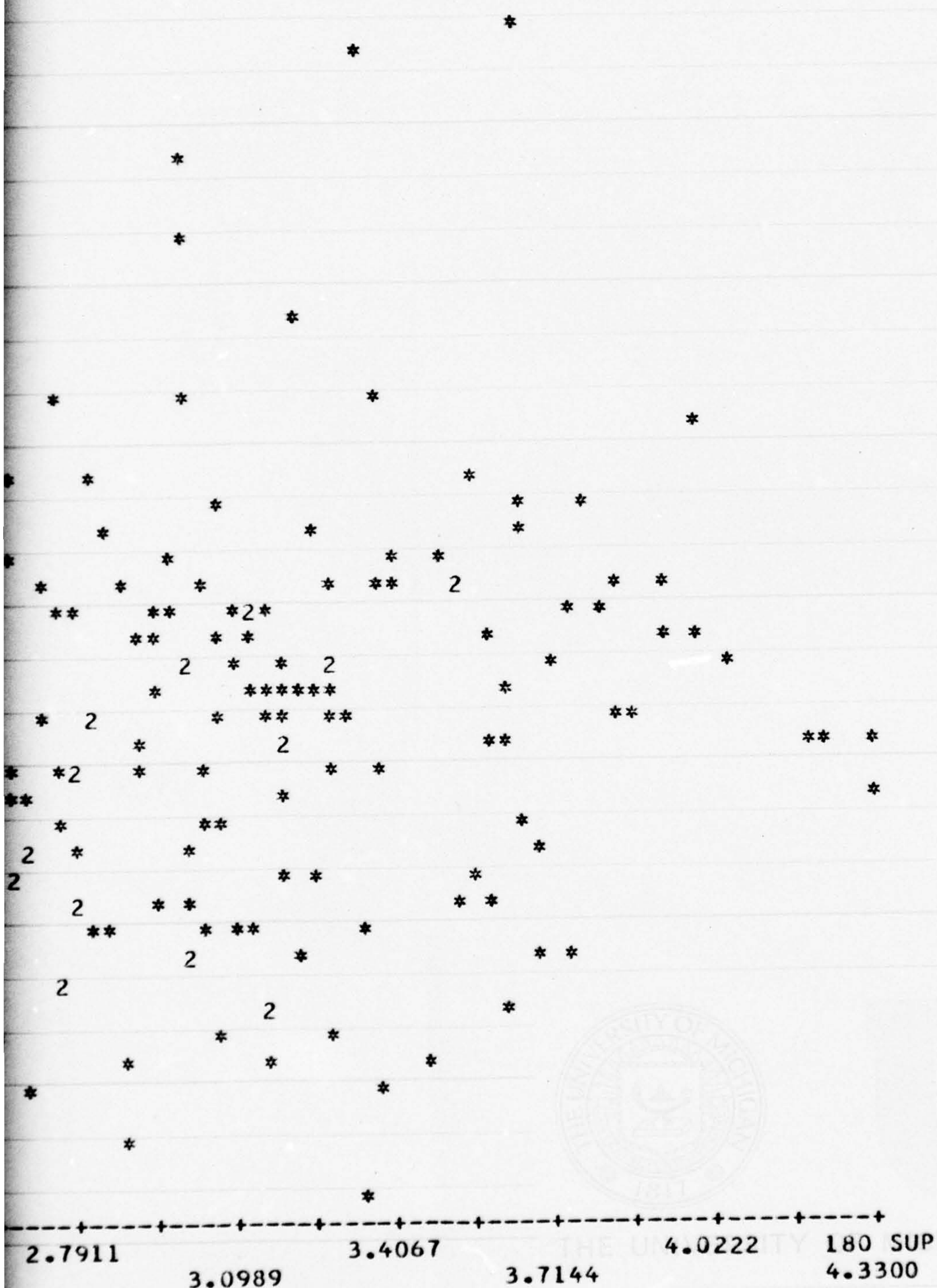

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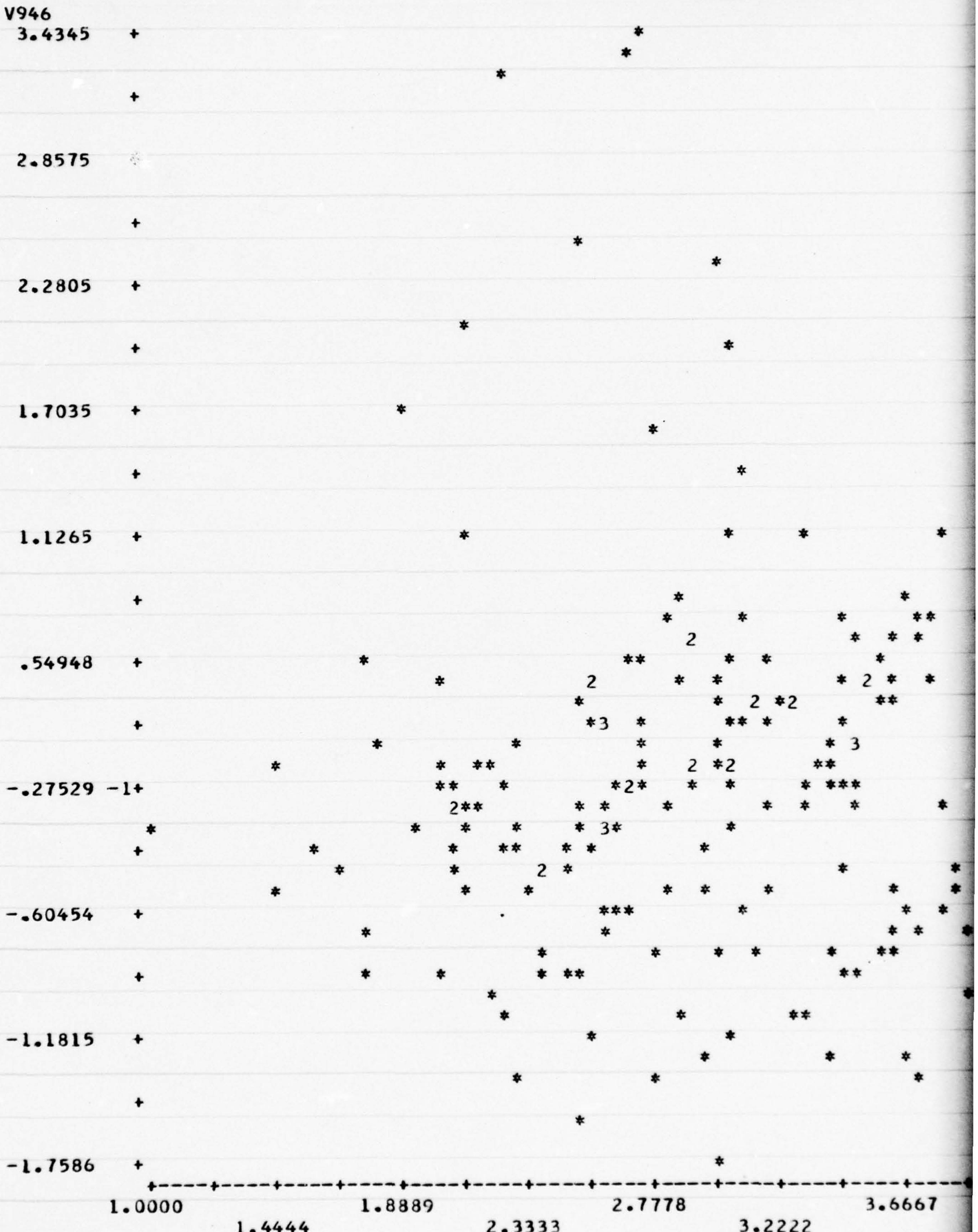

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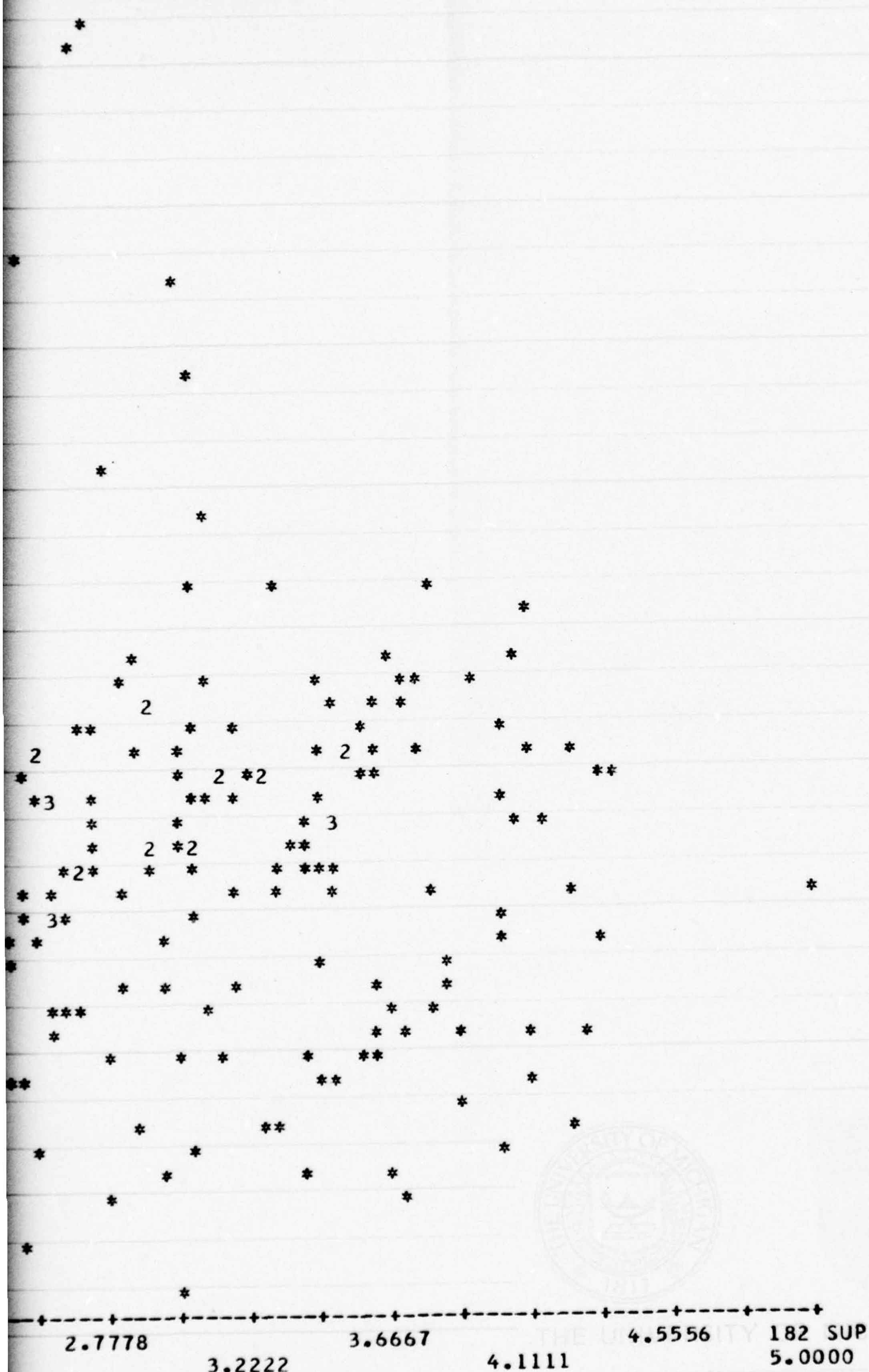

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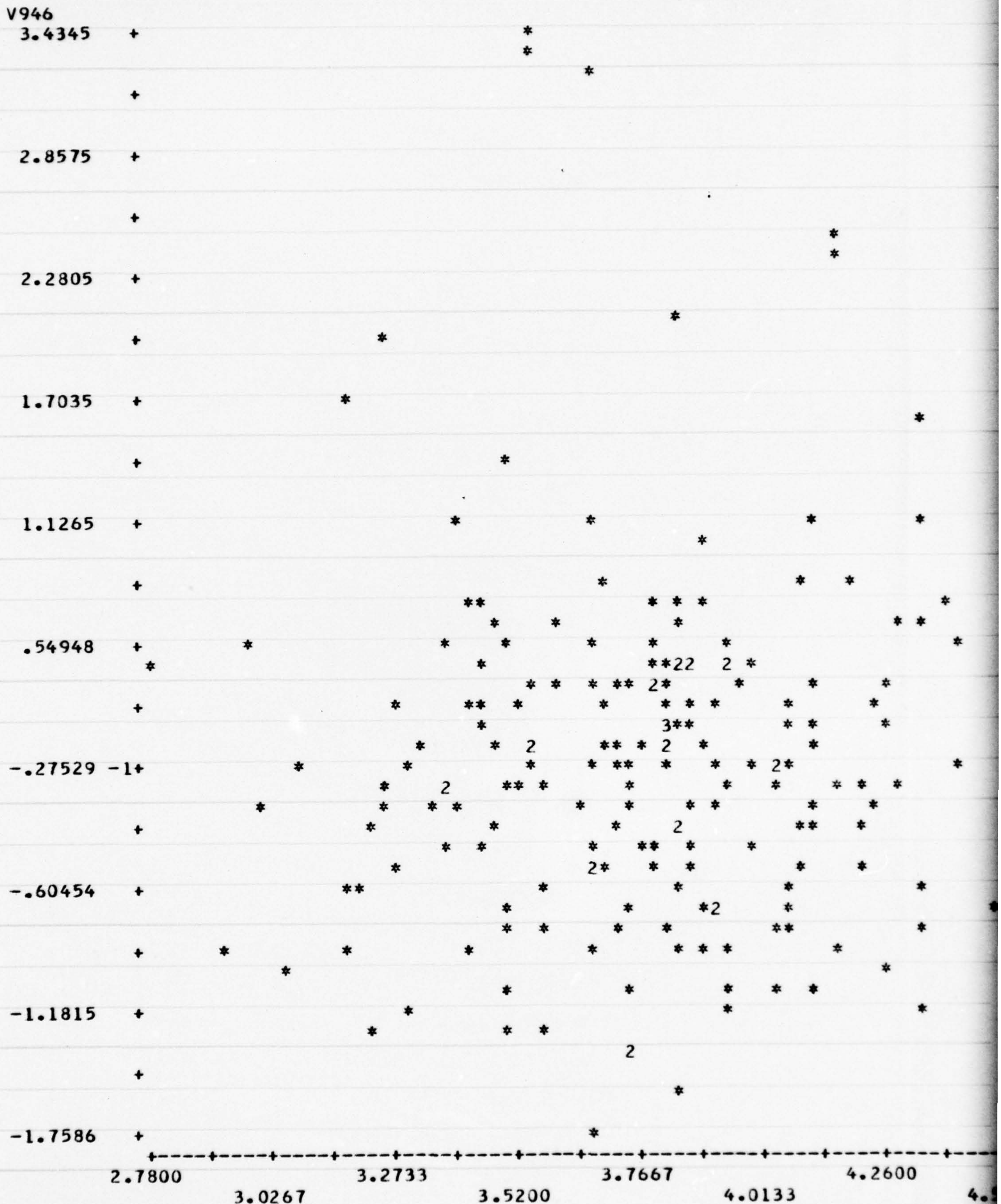

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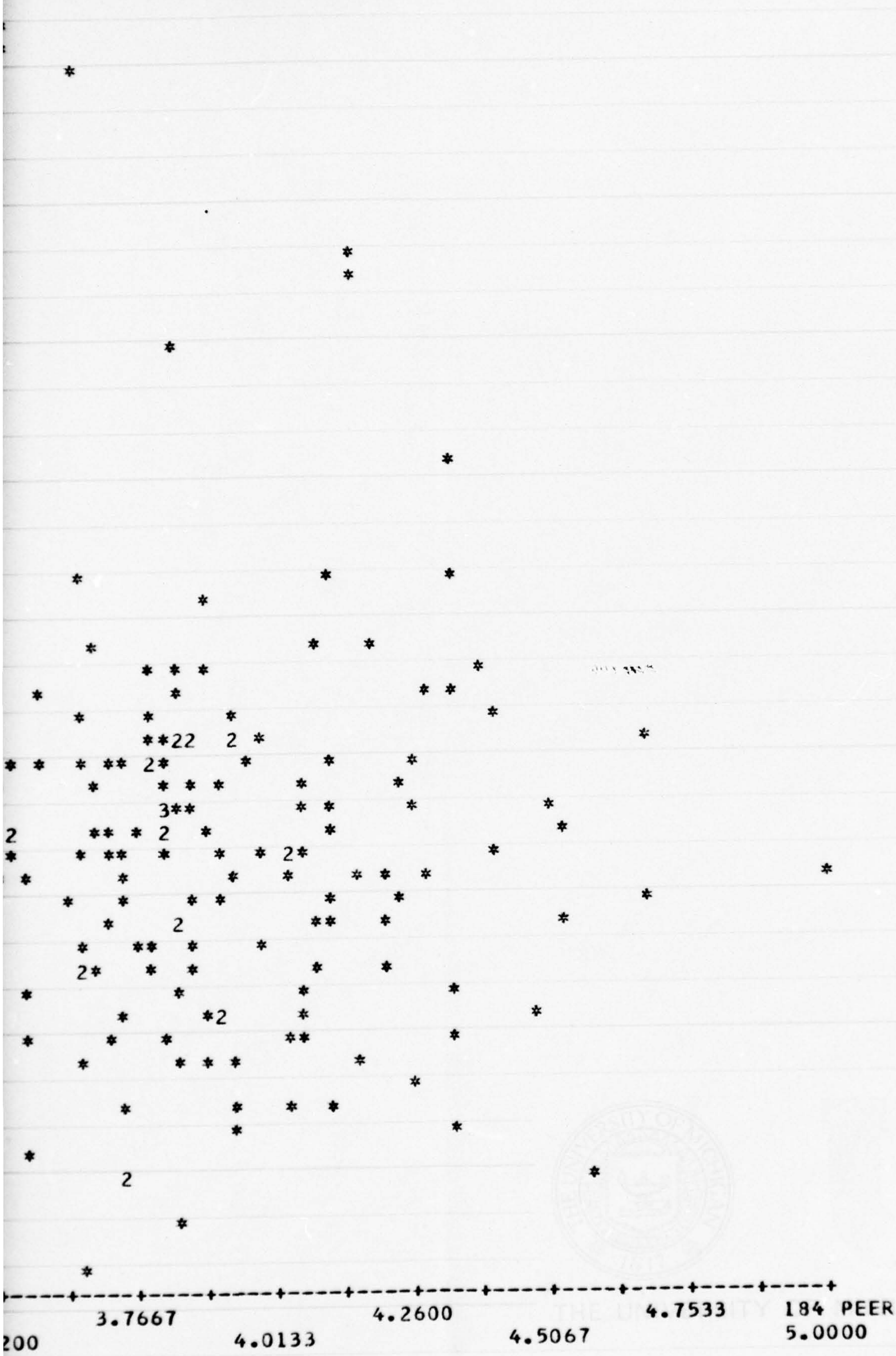

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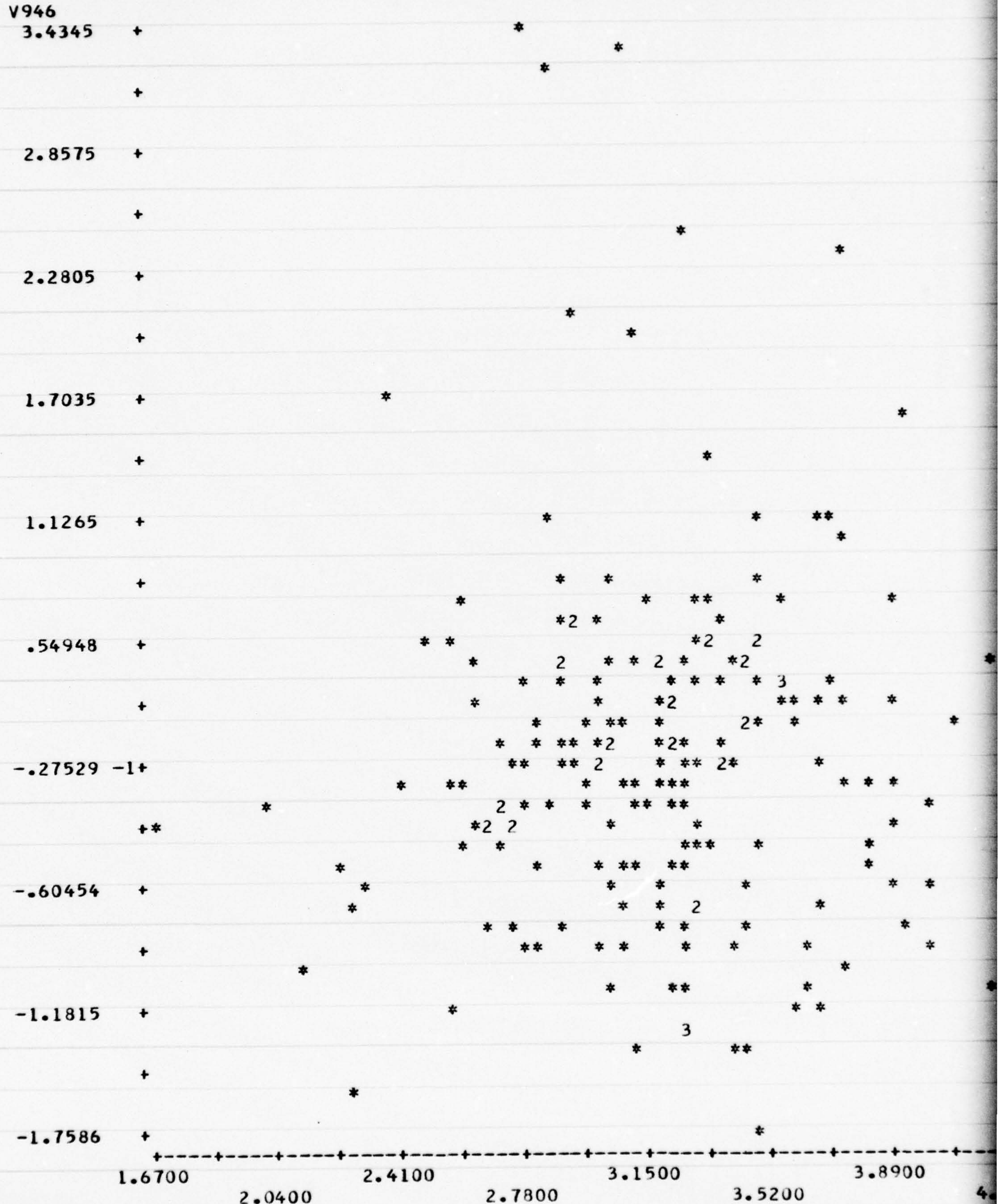

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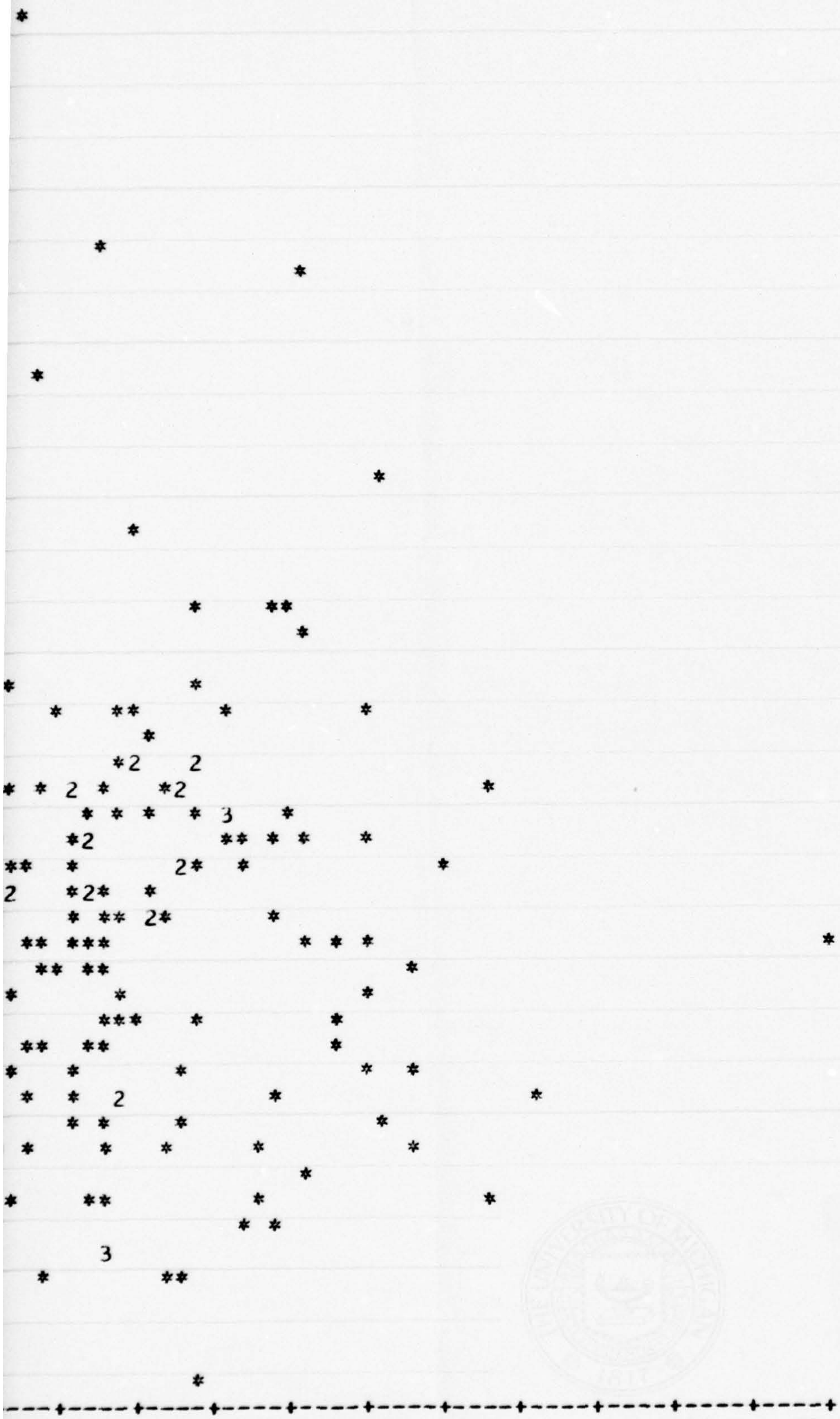

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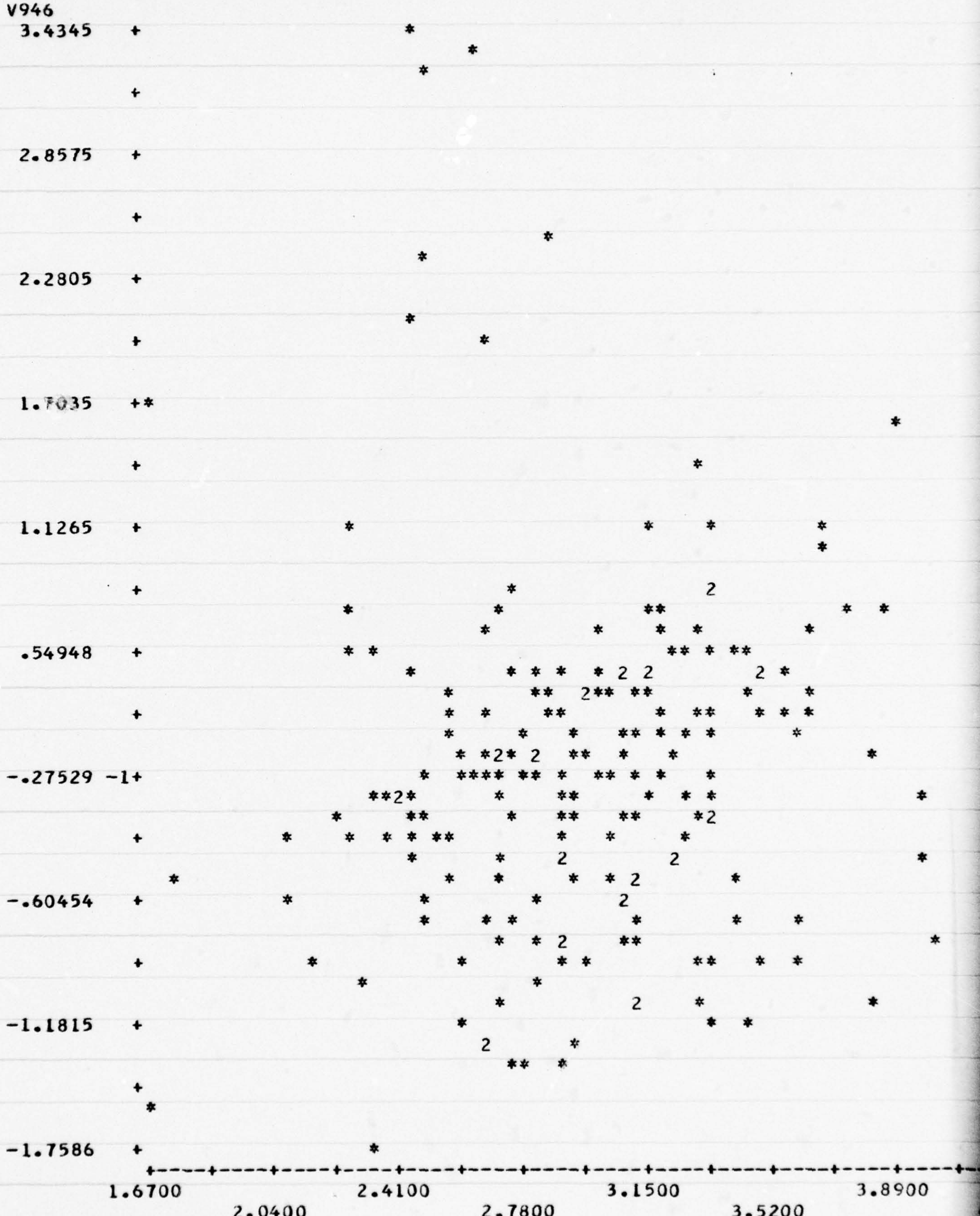

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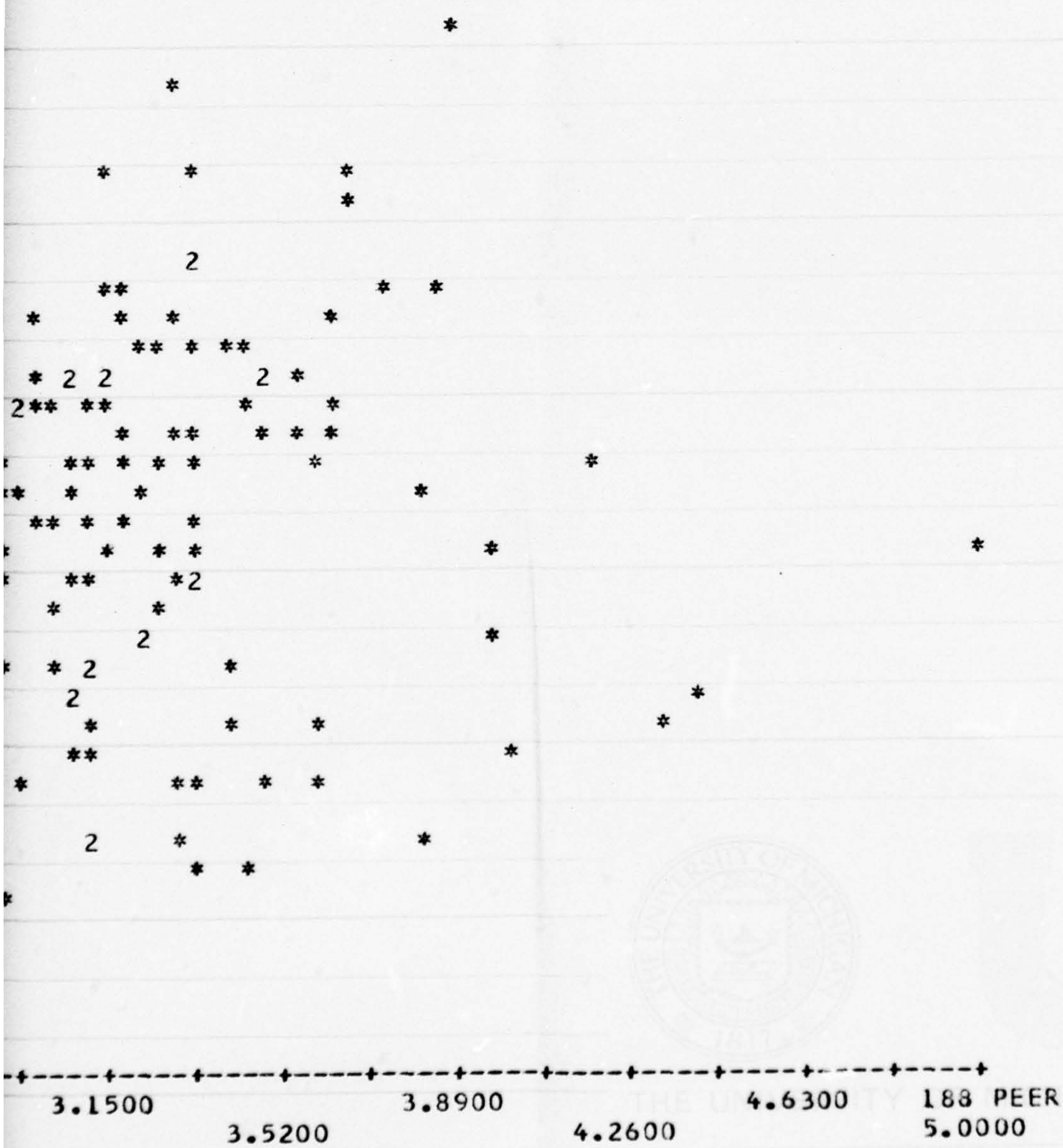

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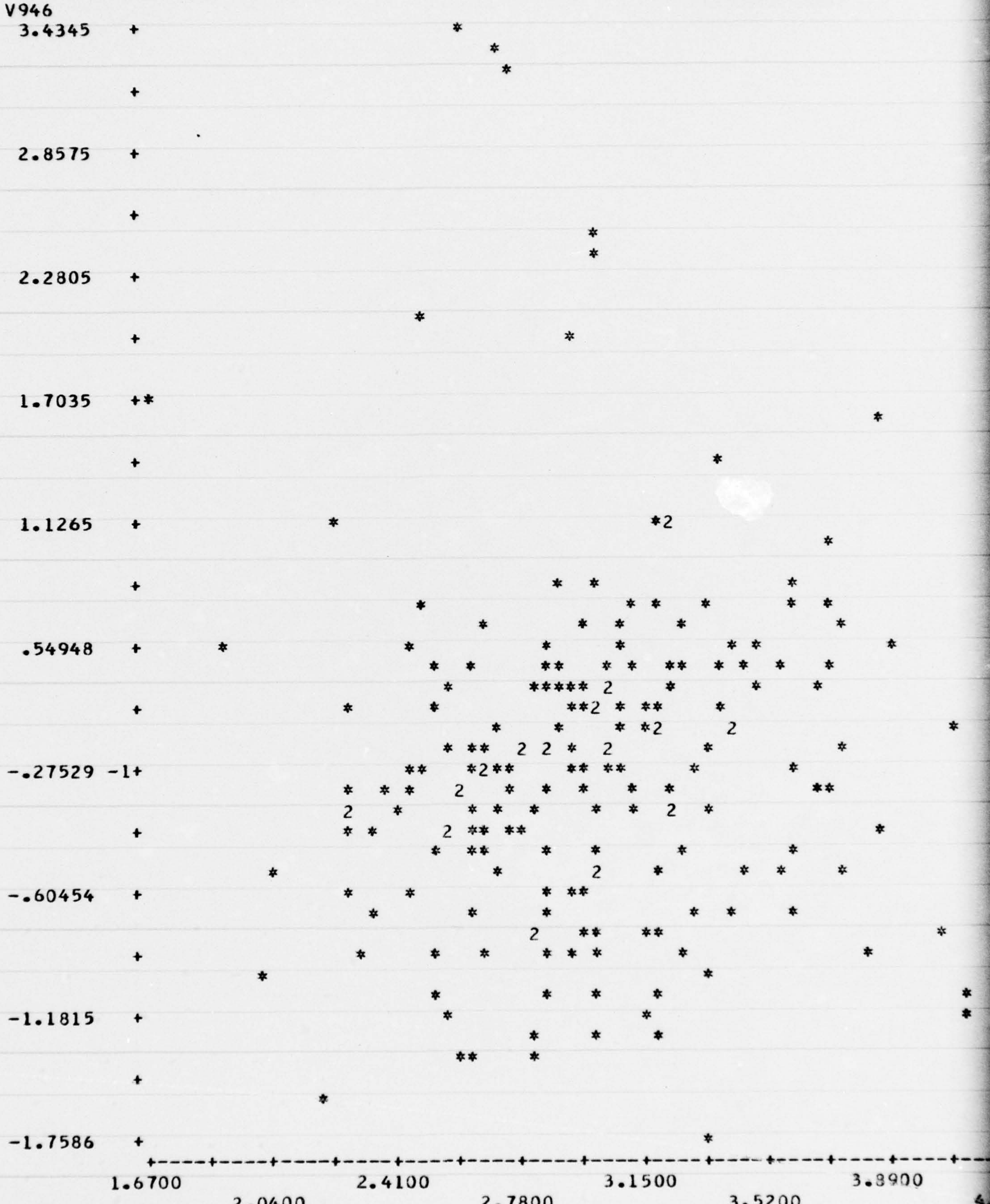

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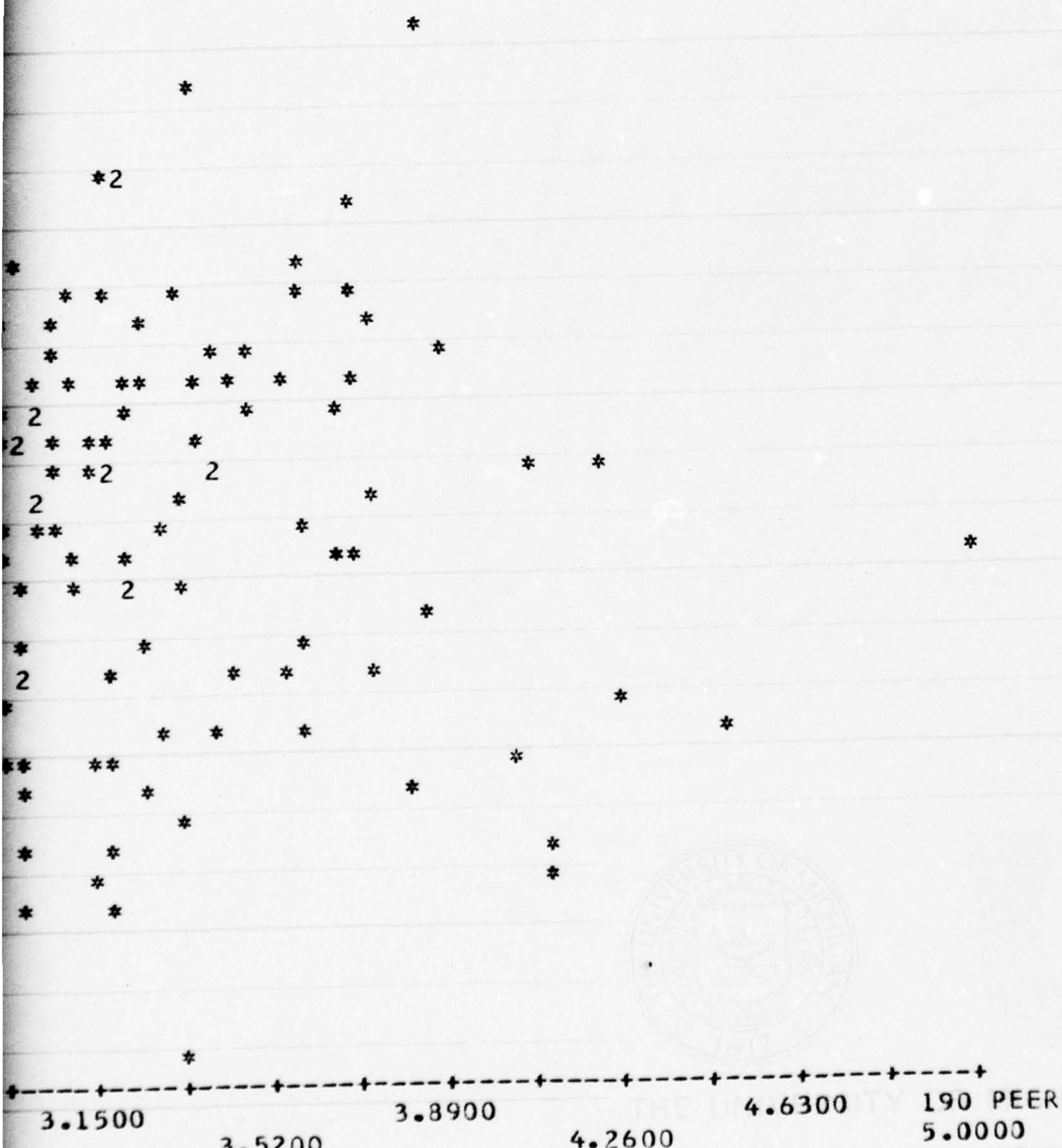

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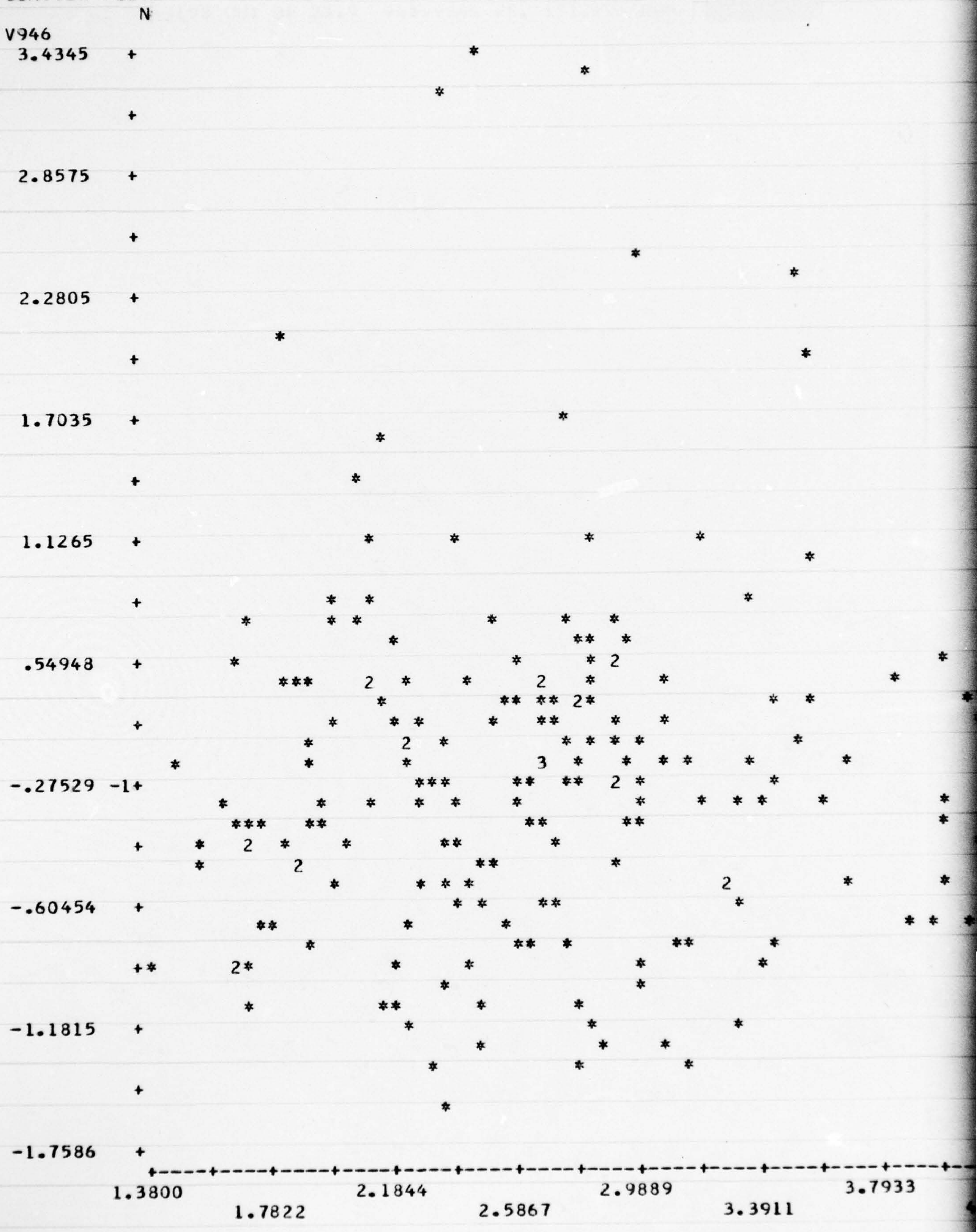


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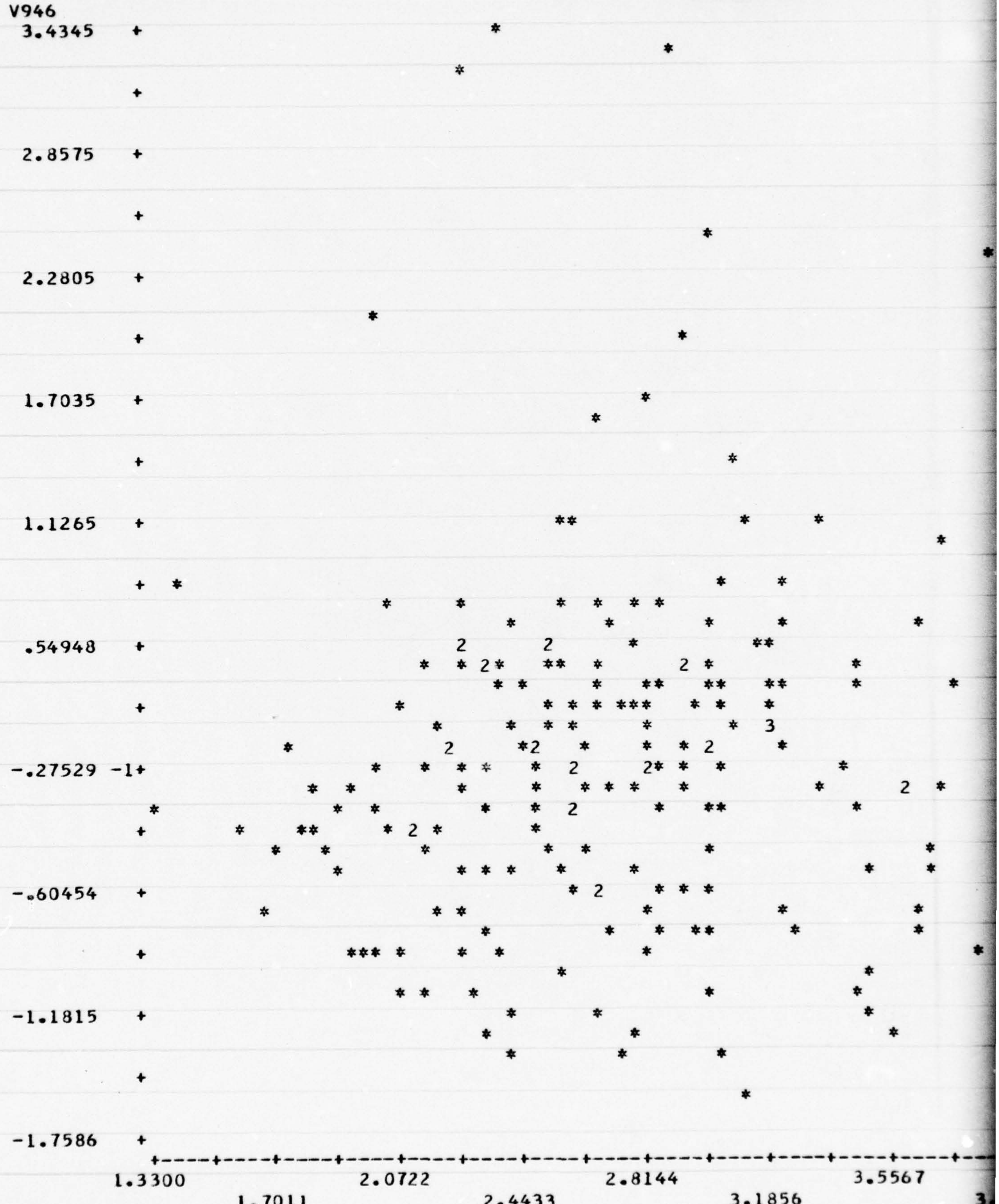

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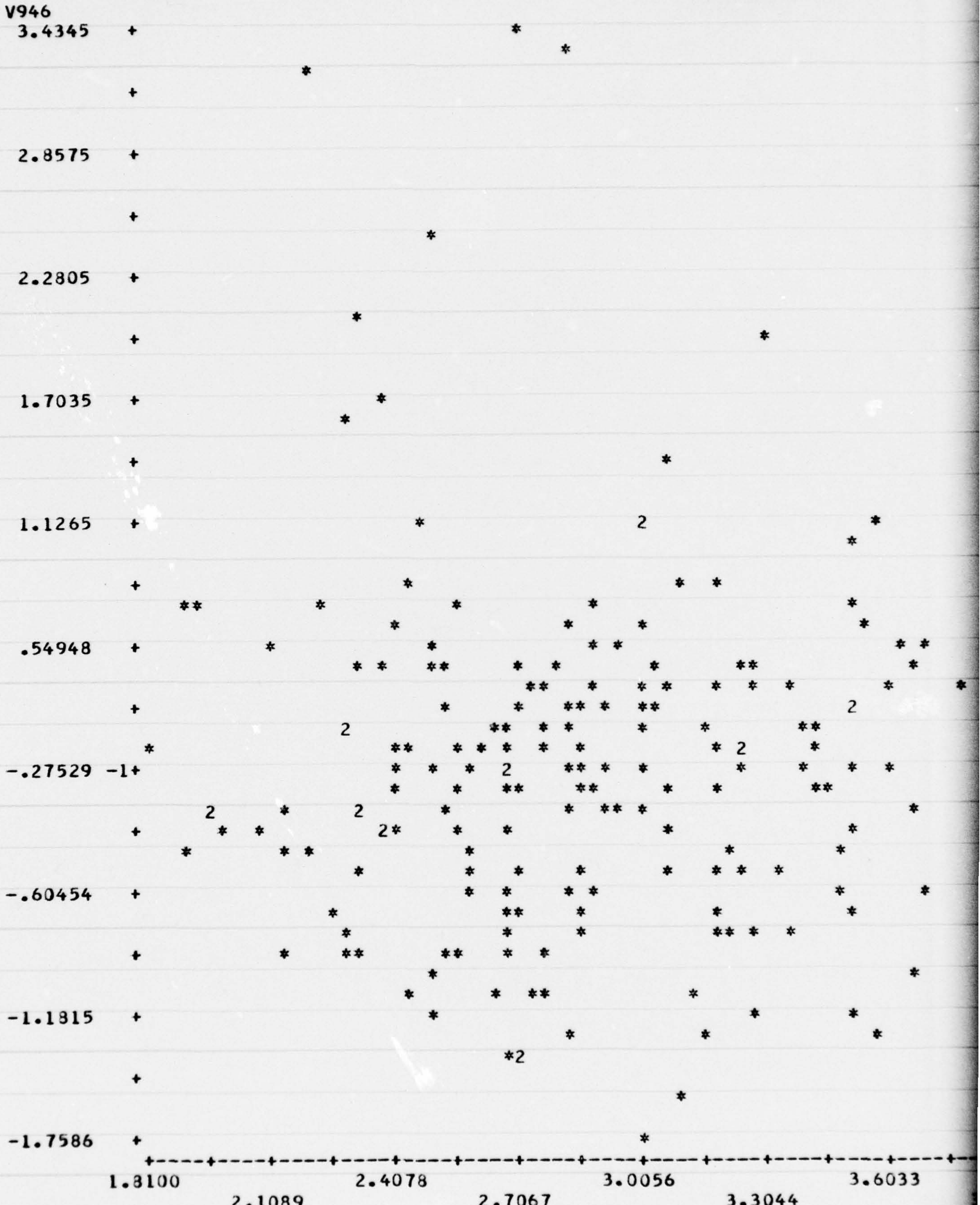

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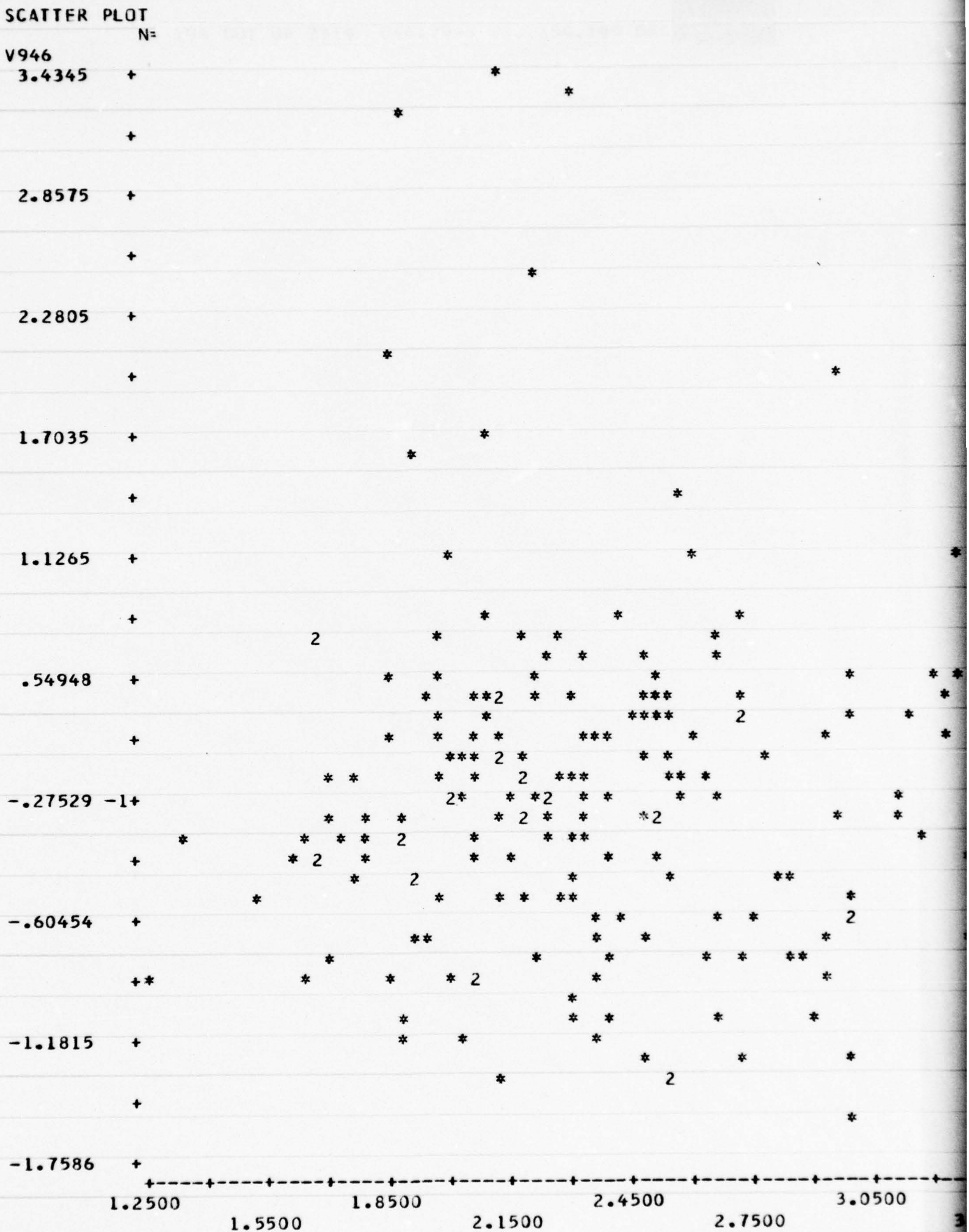
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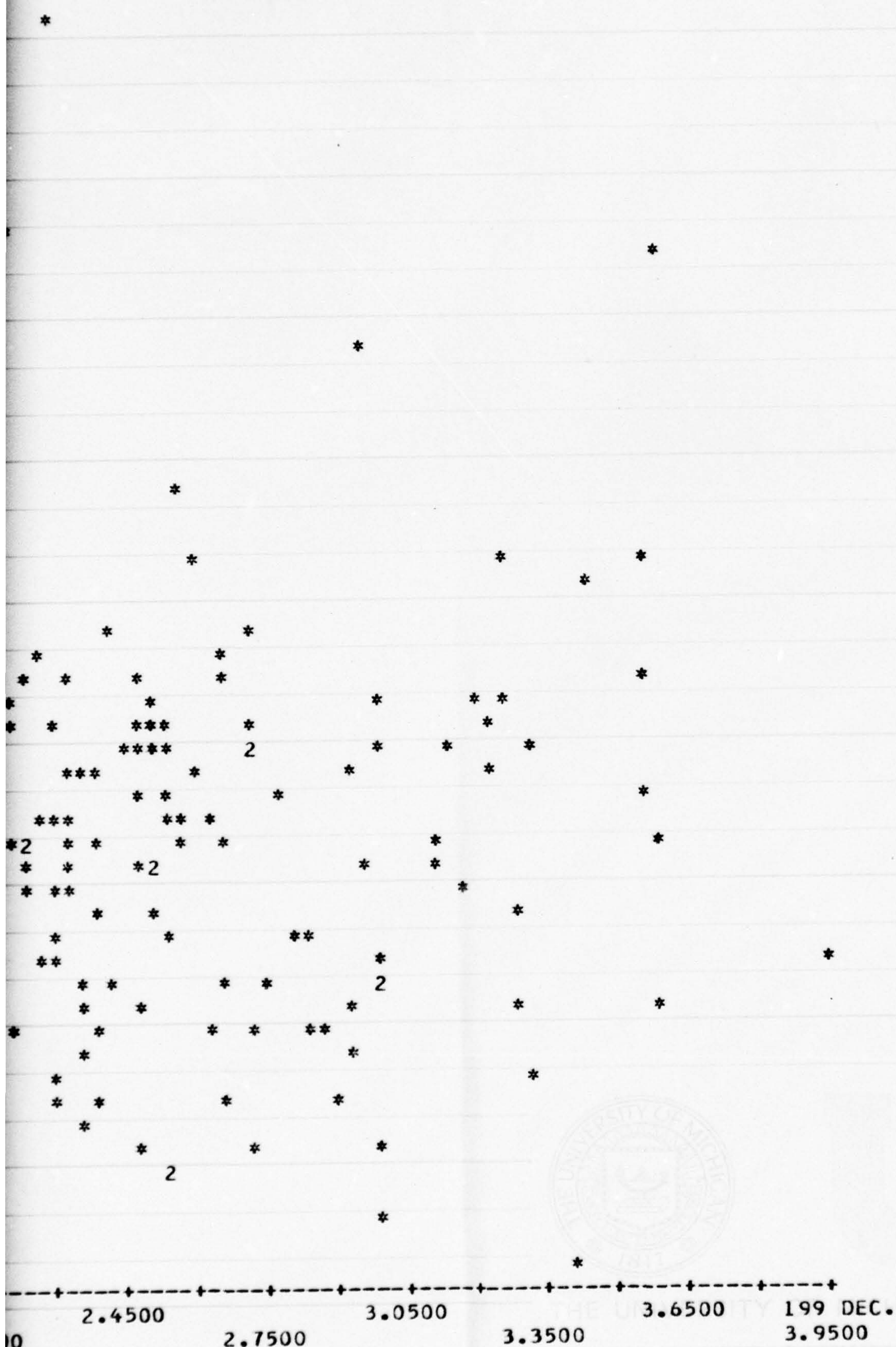

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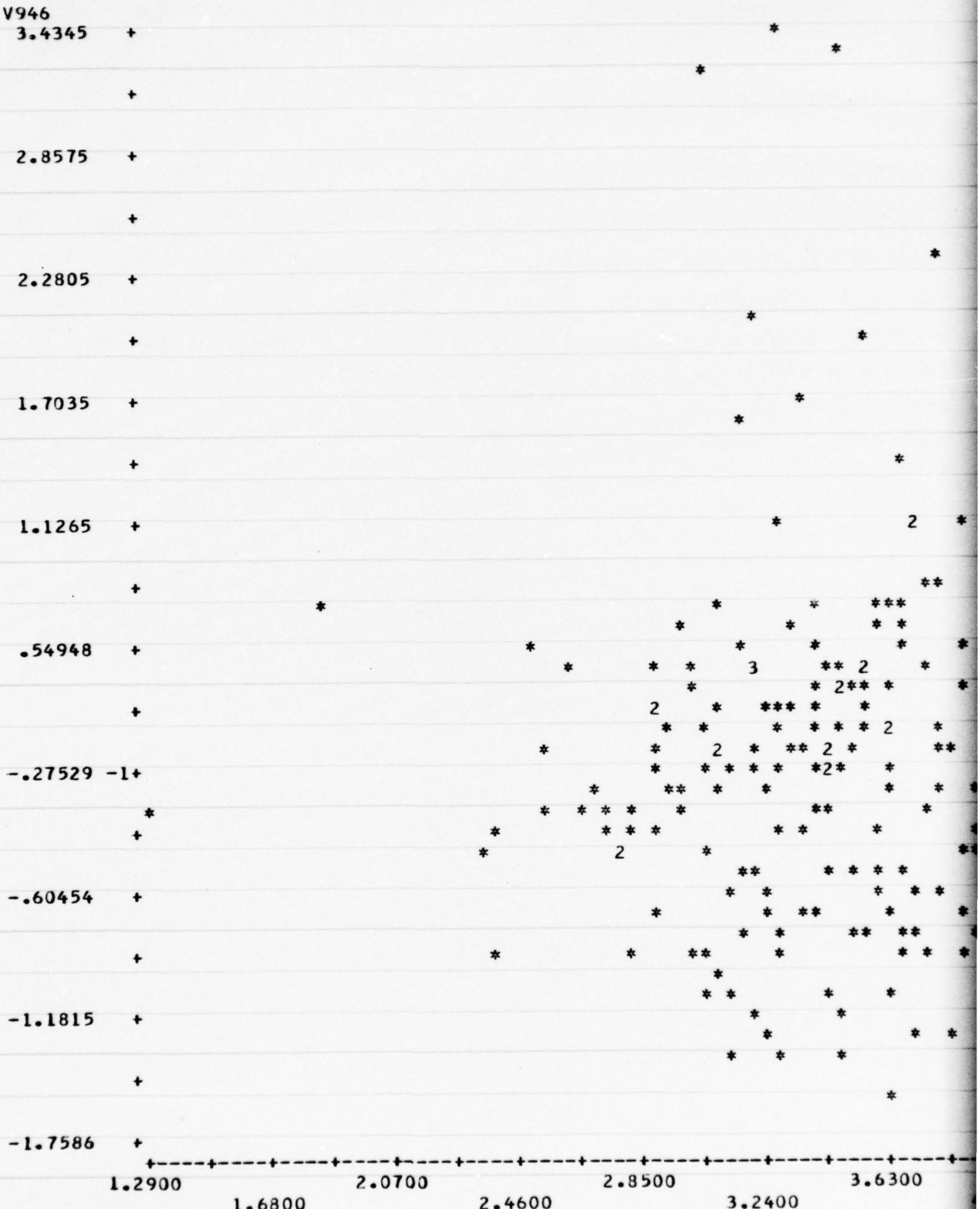

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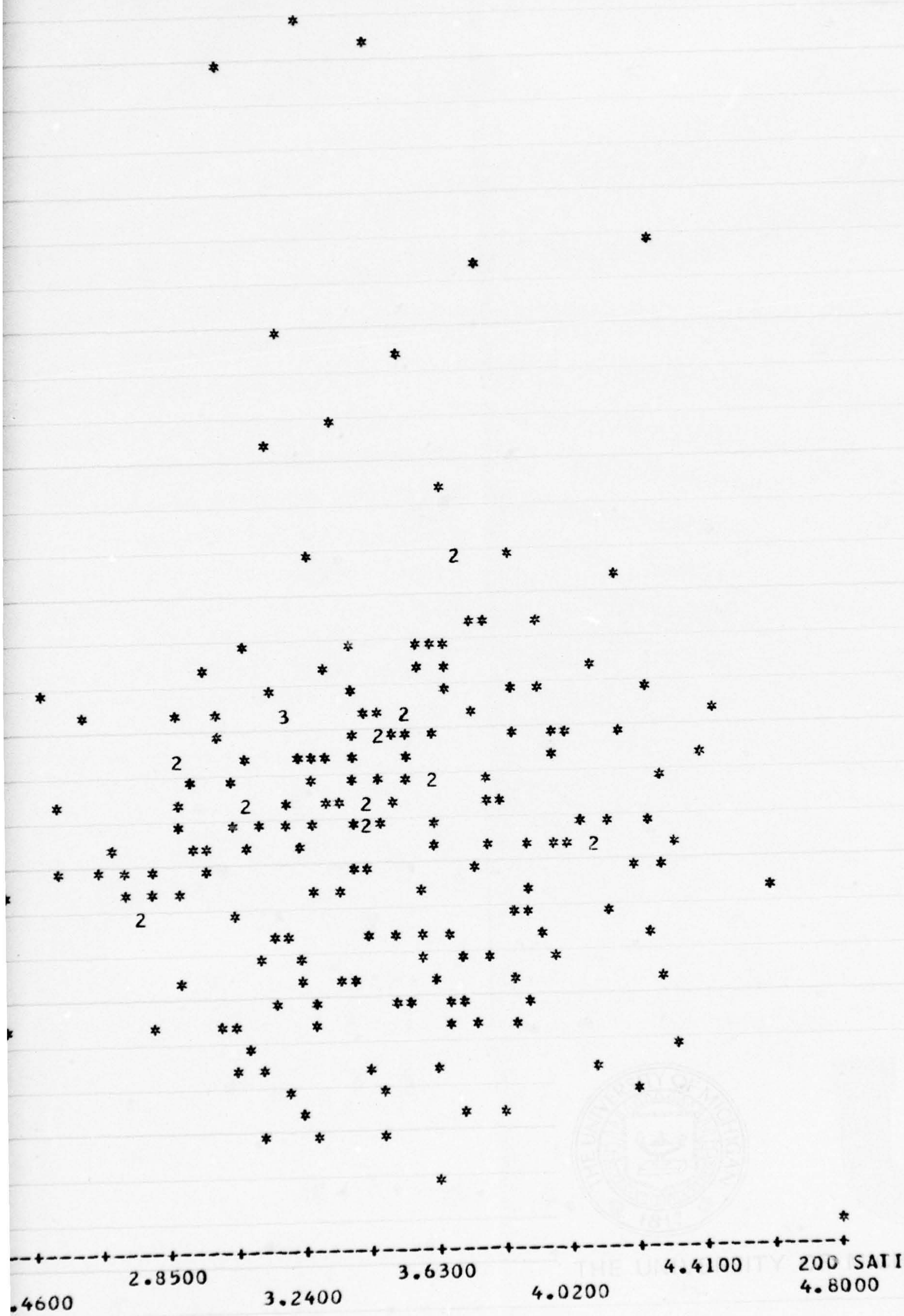

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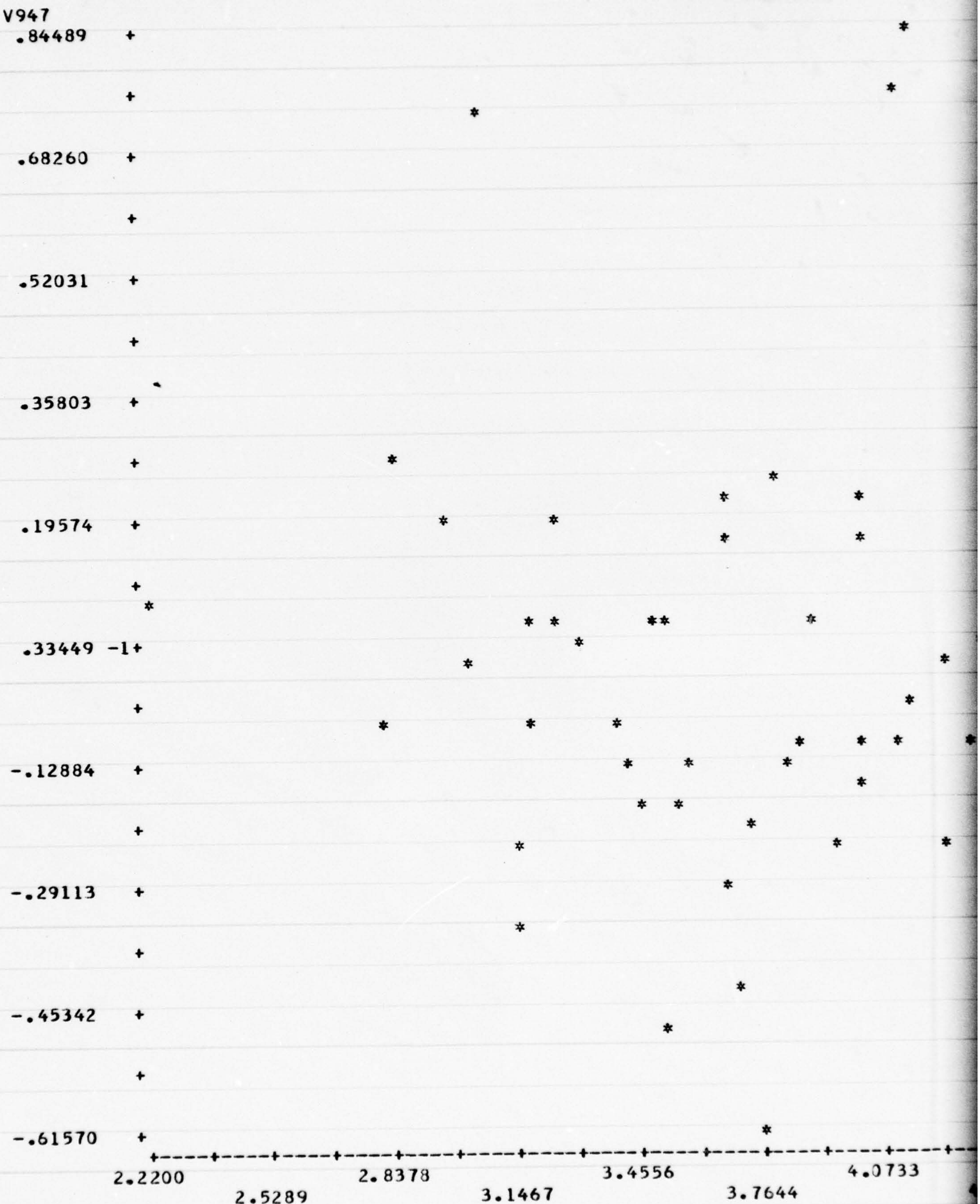

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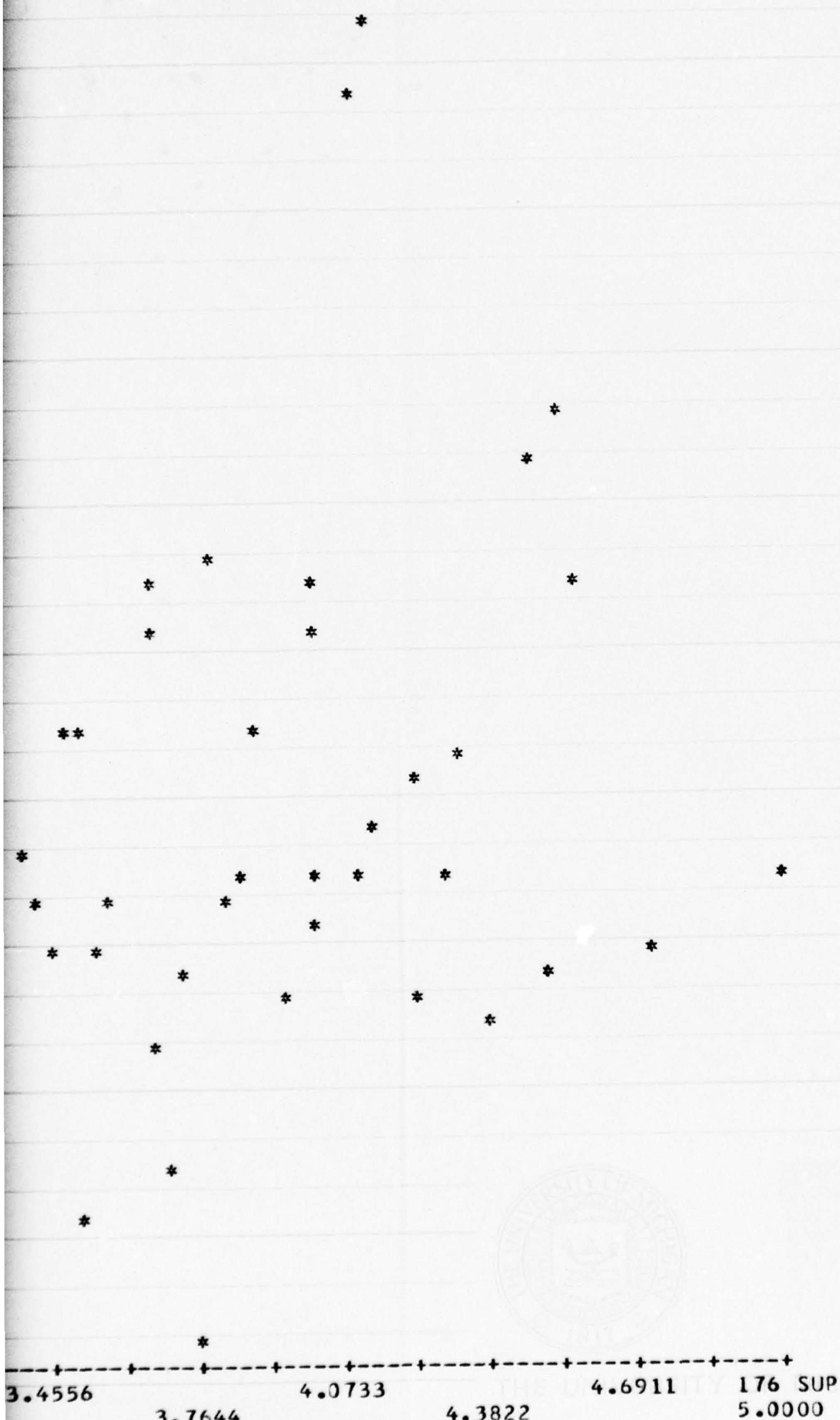

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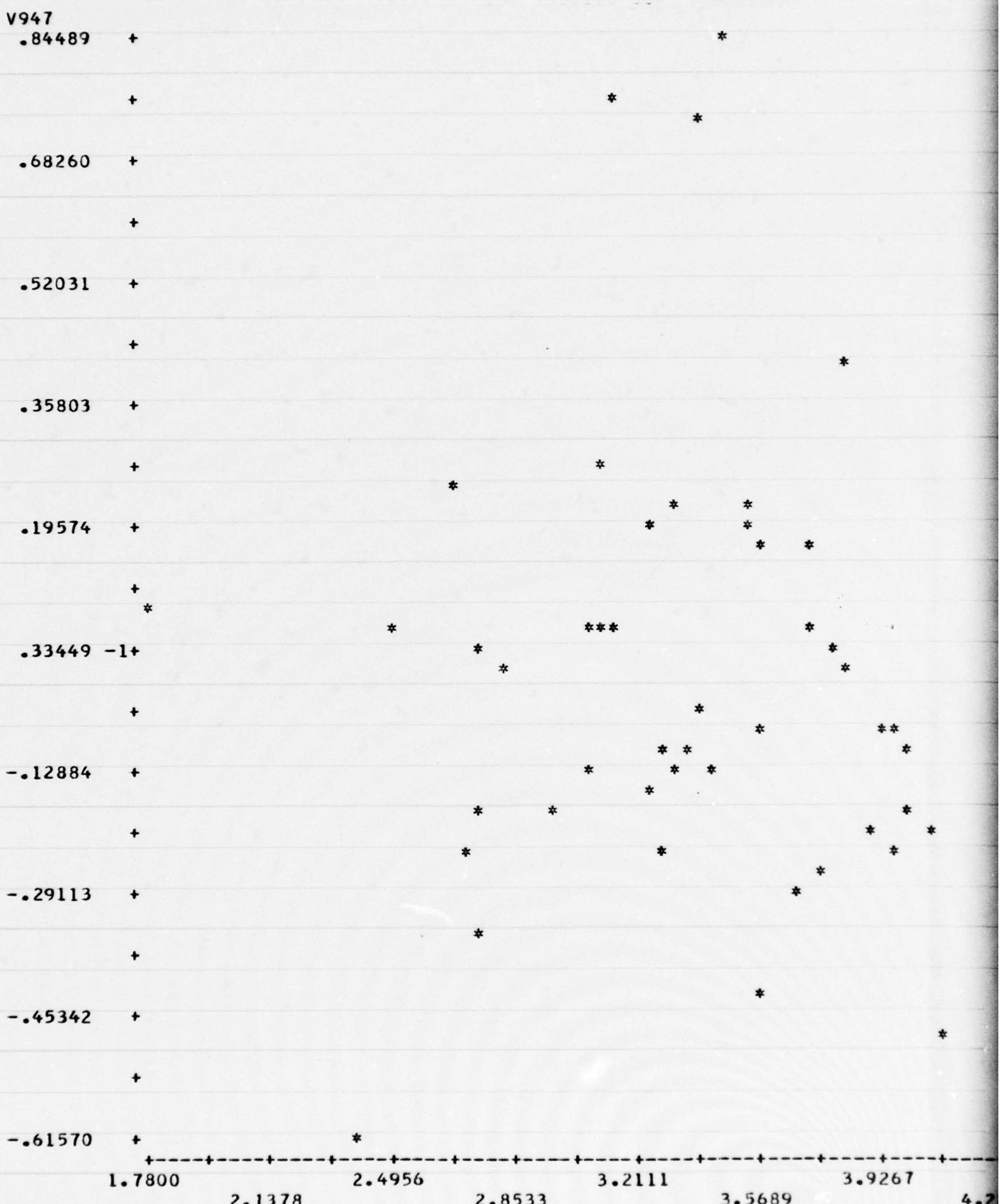

B-82

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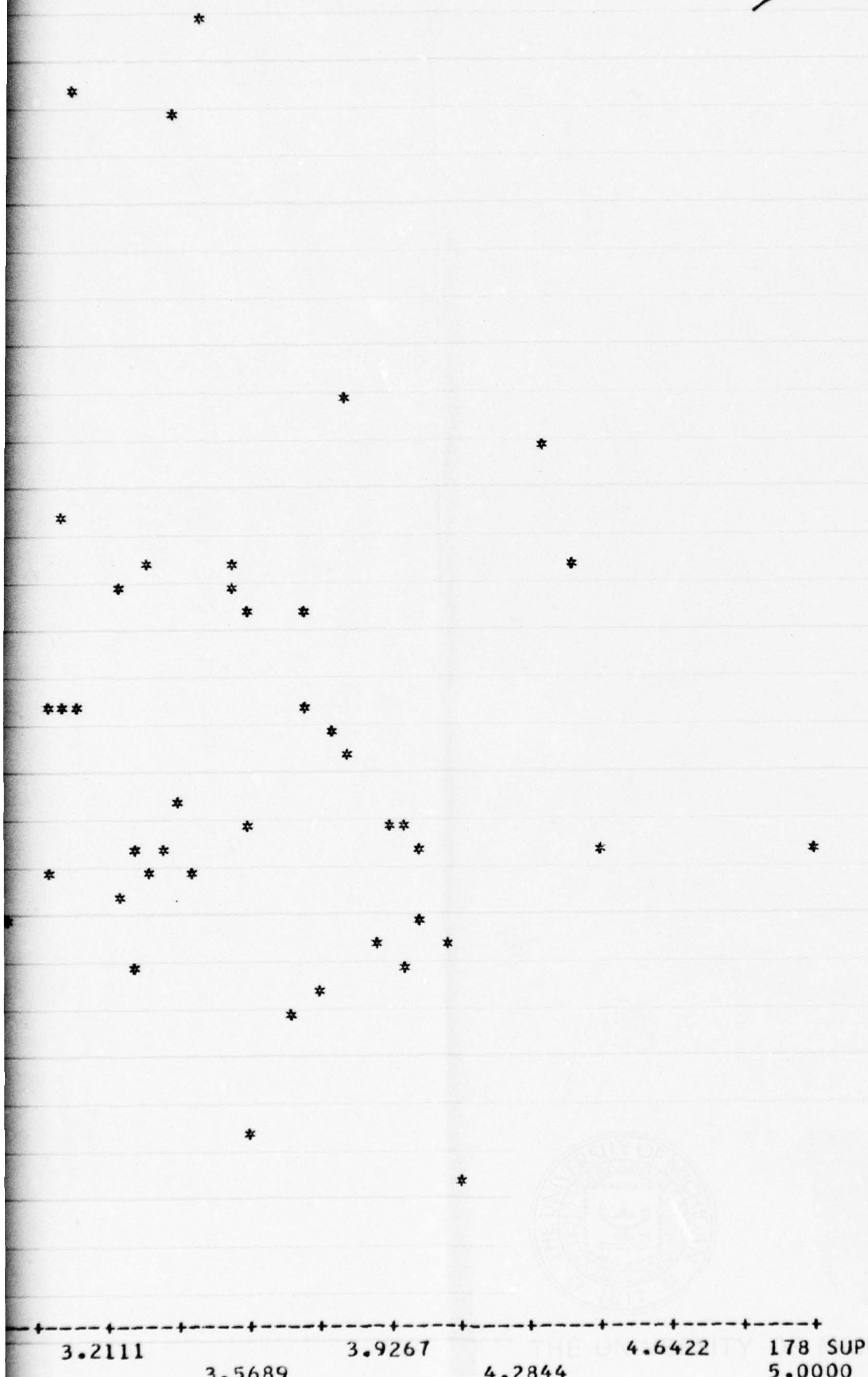

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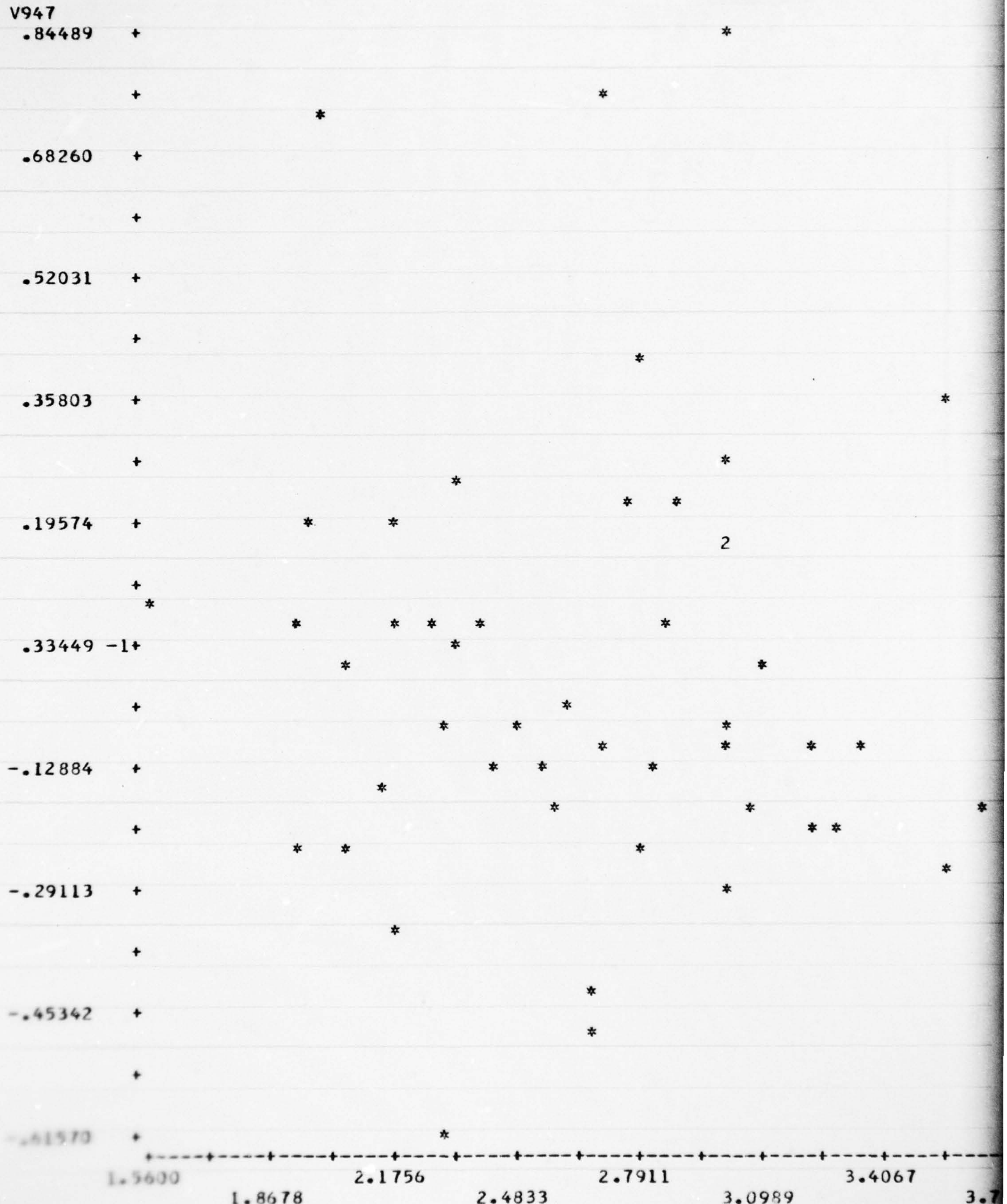

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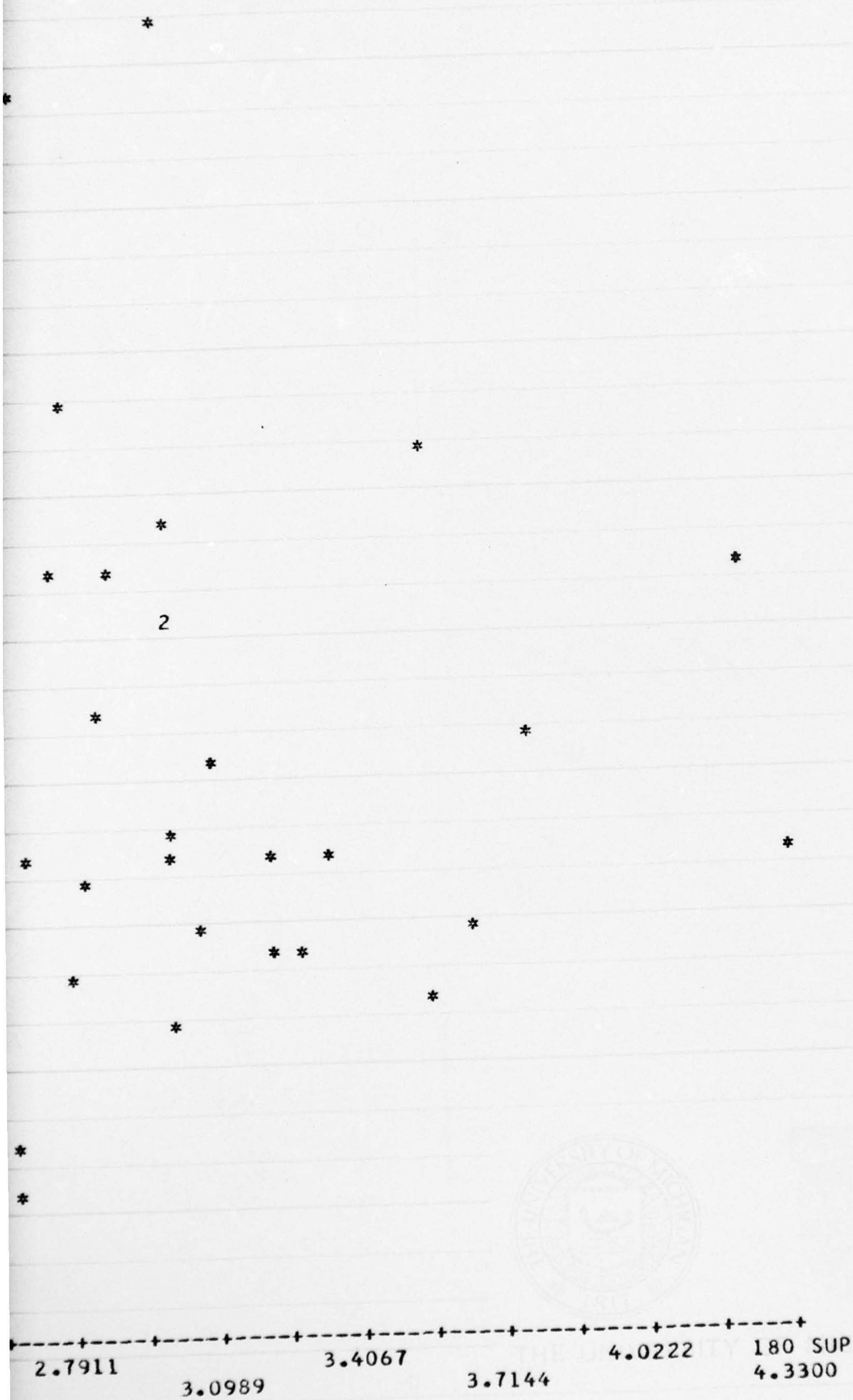

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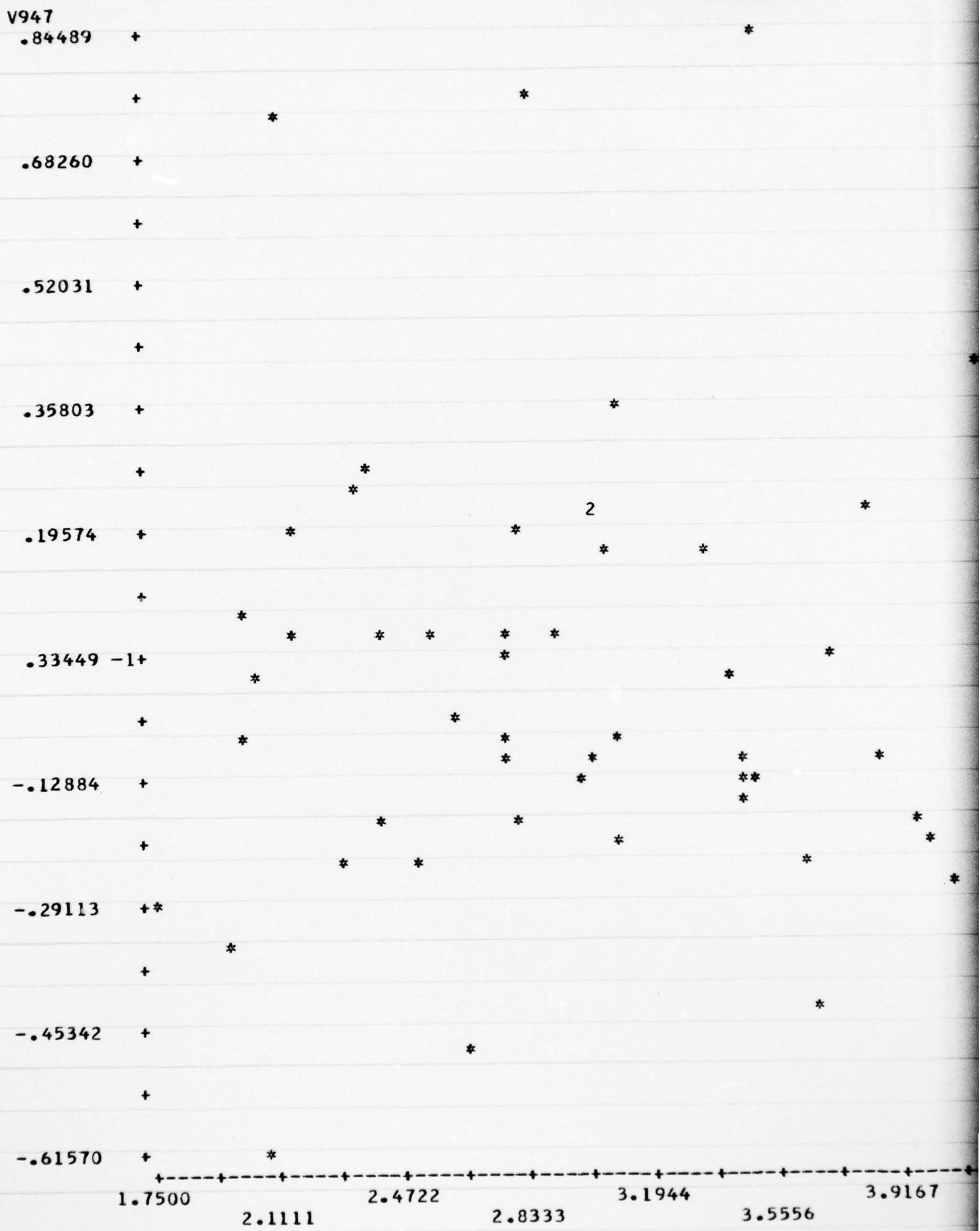

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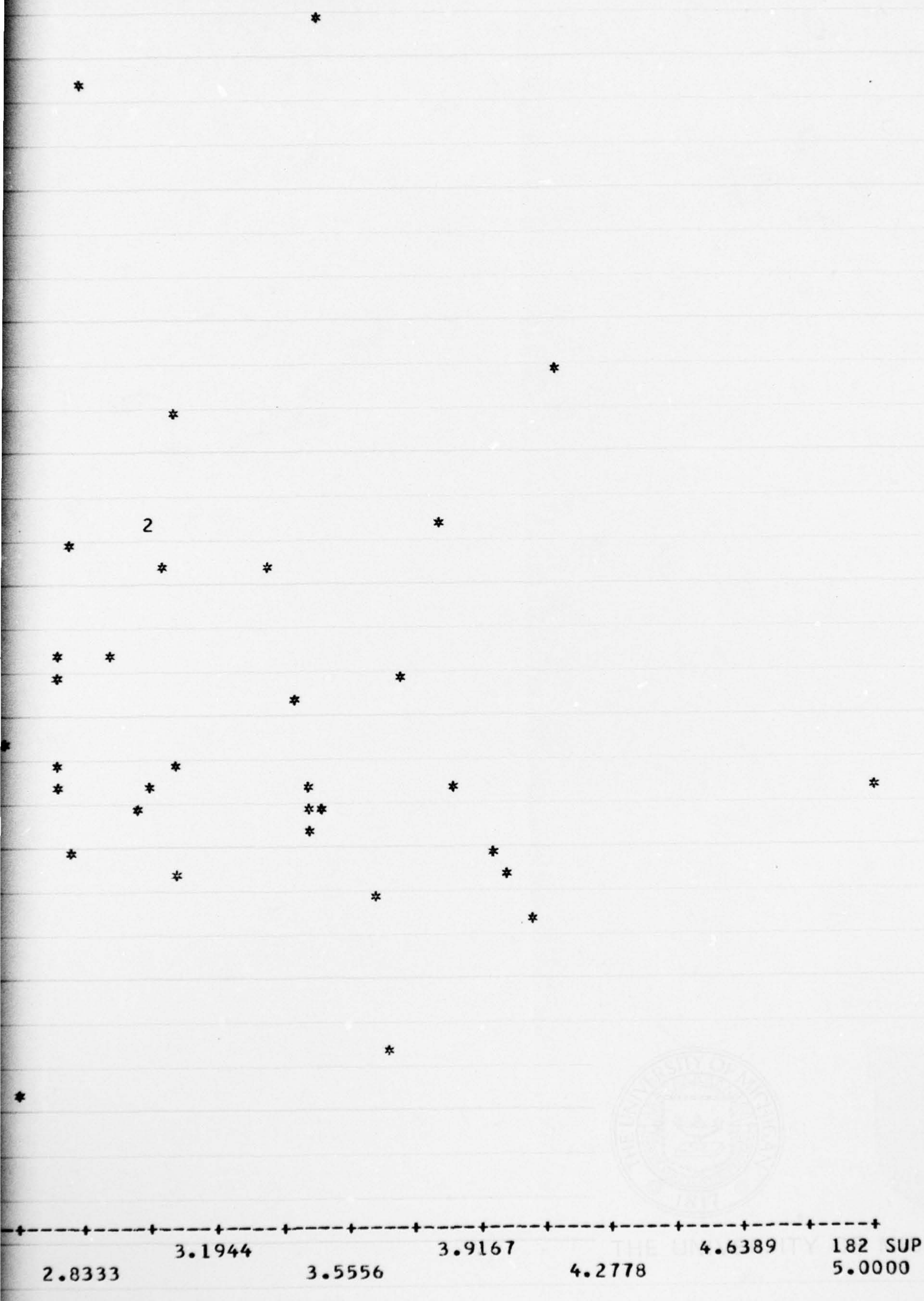

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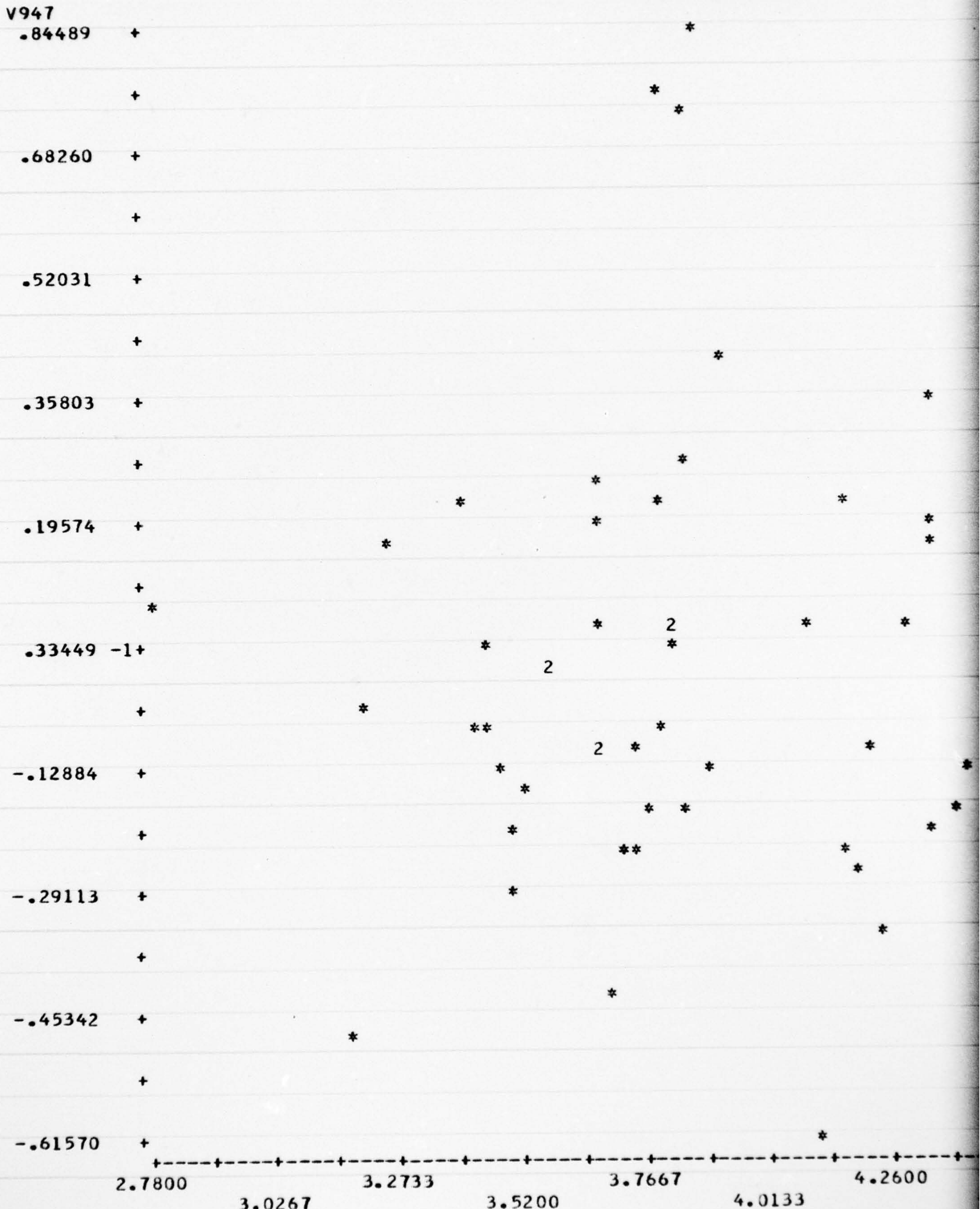

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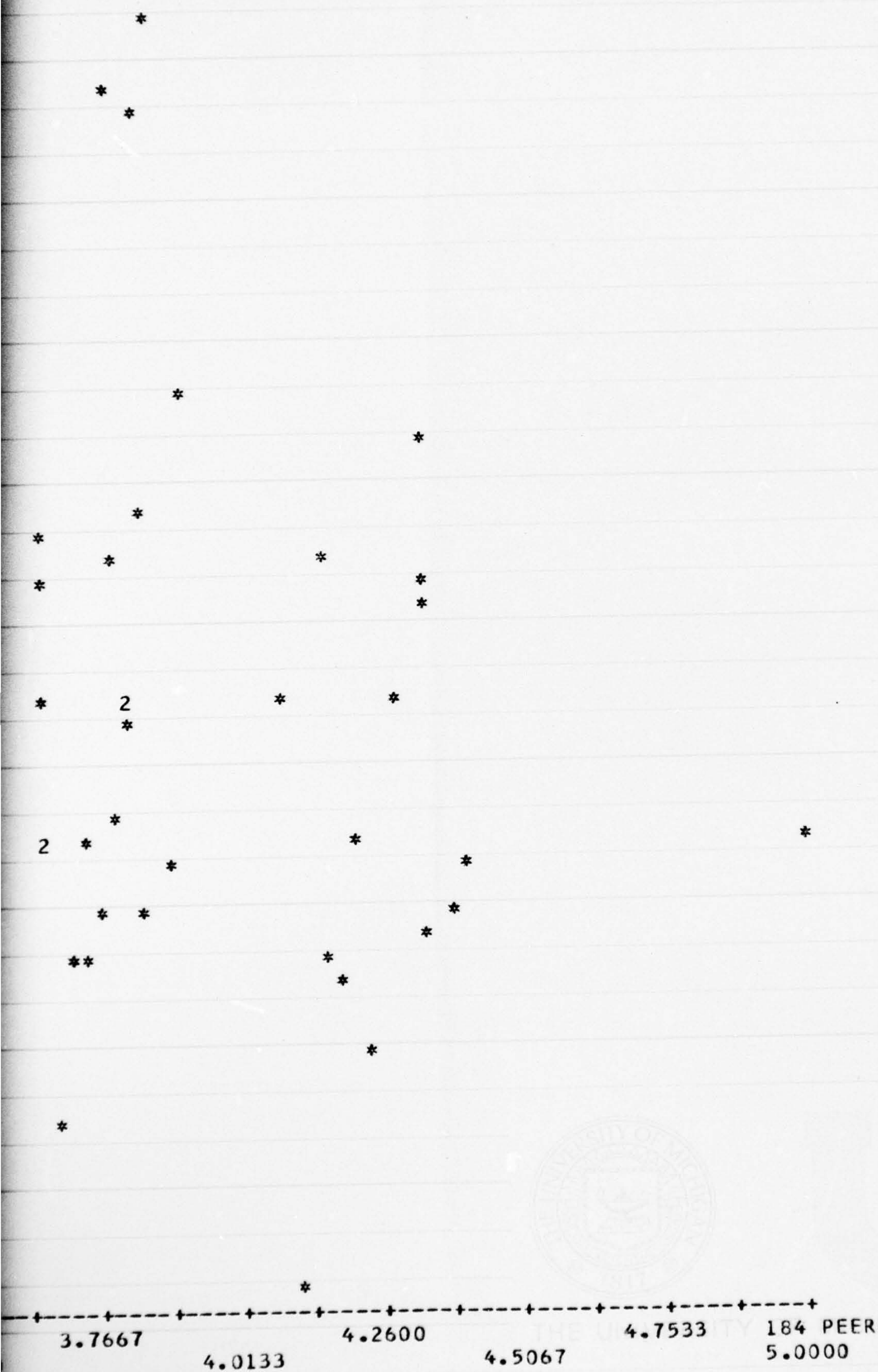

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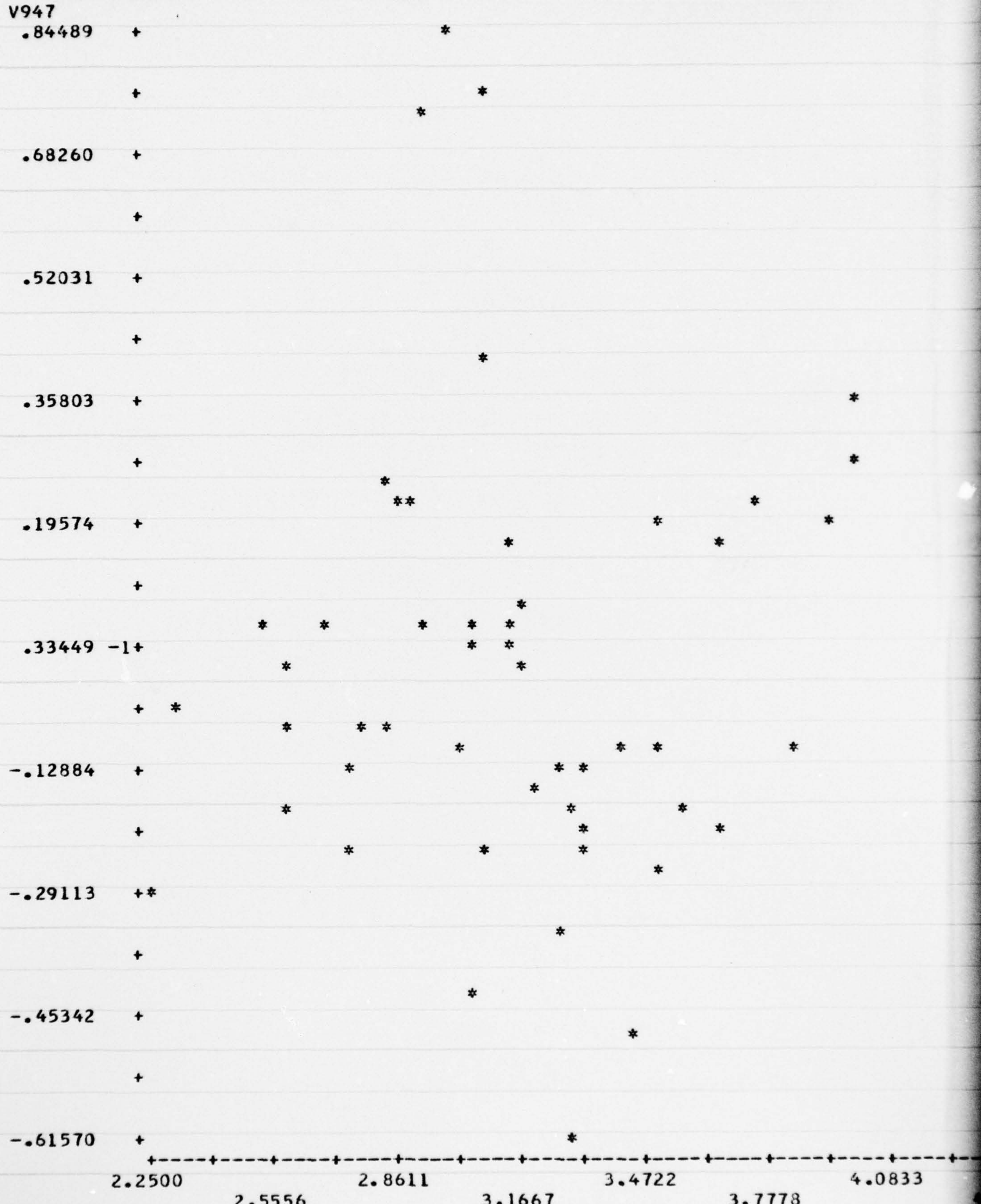

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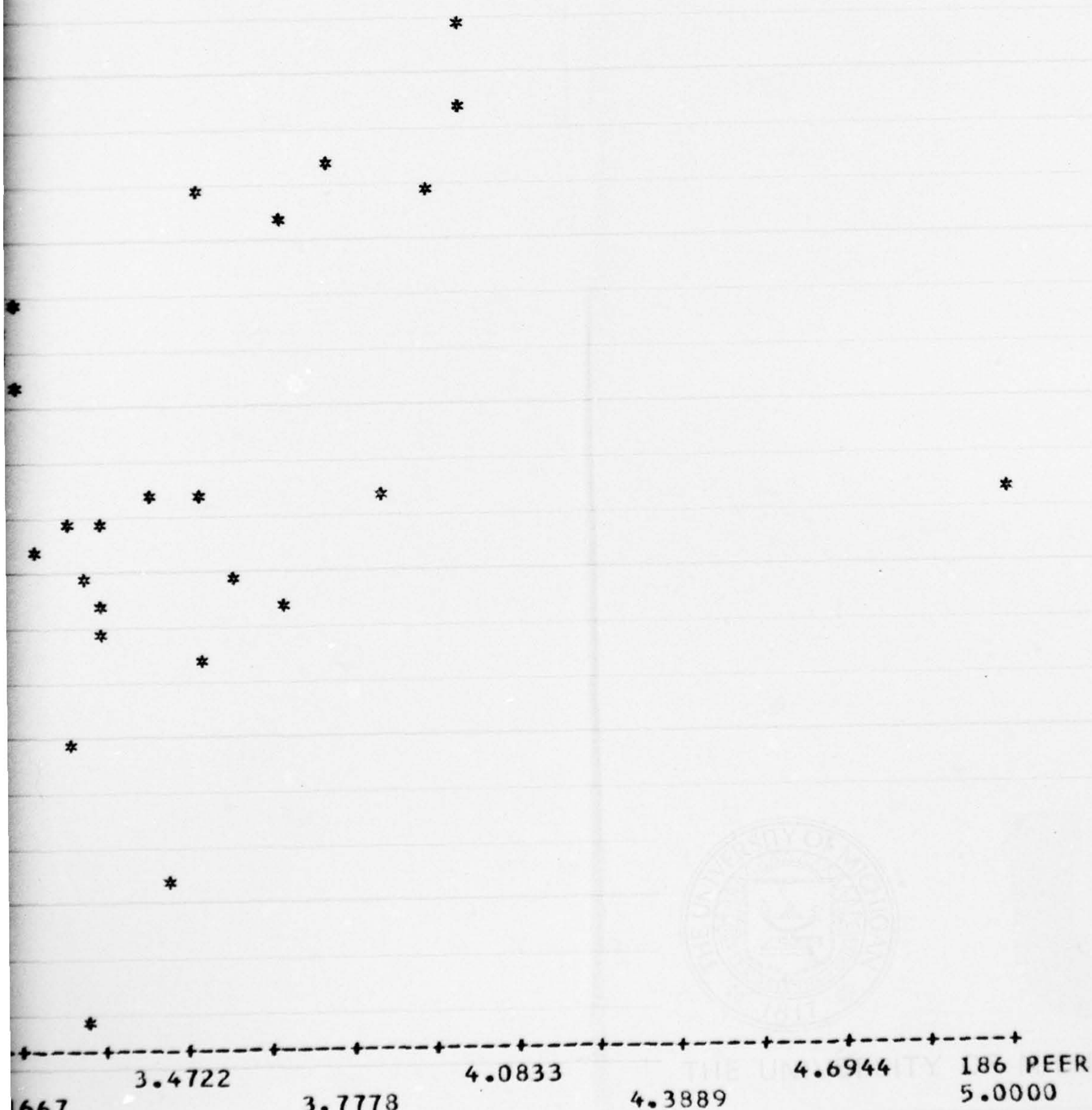

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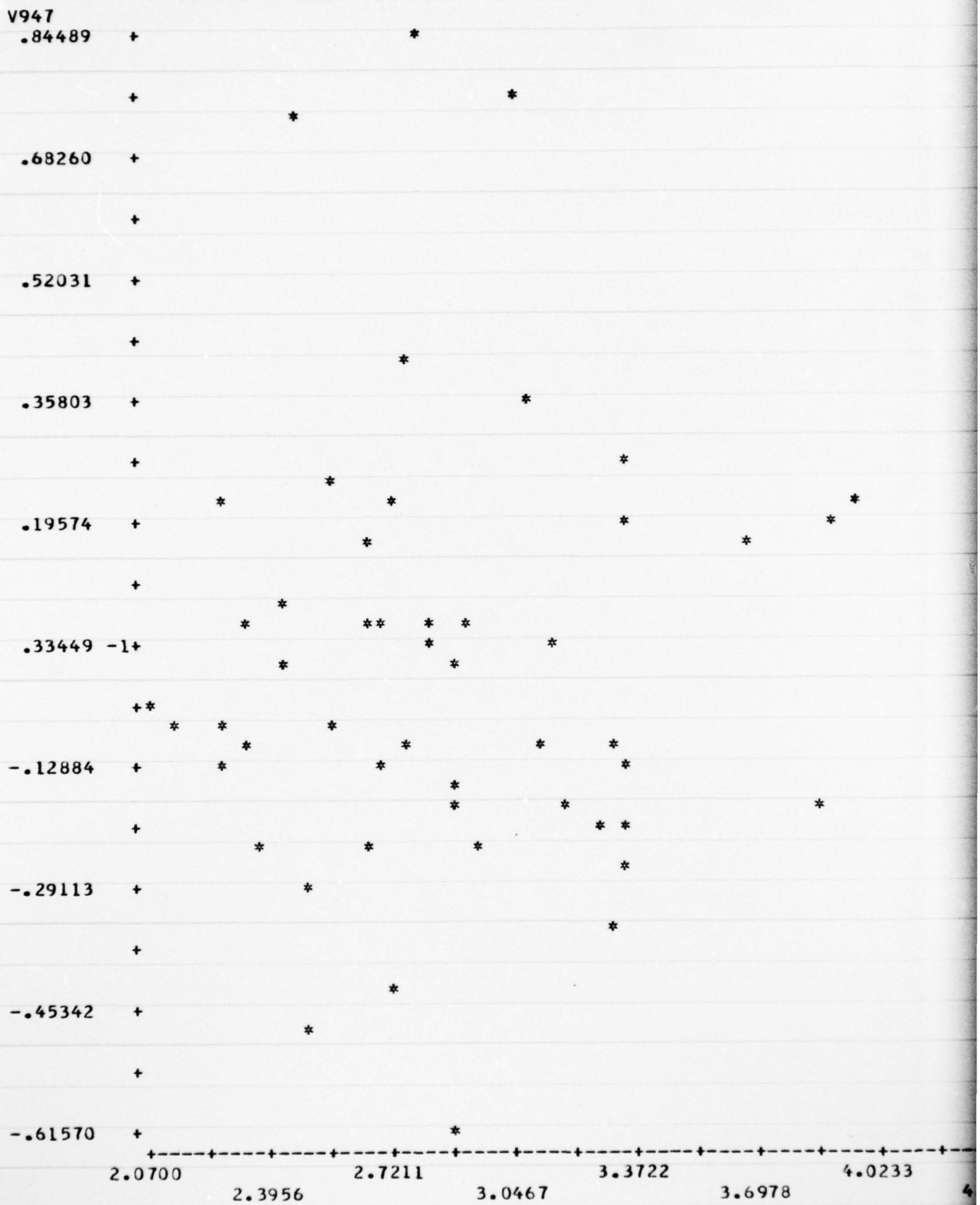

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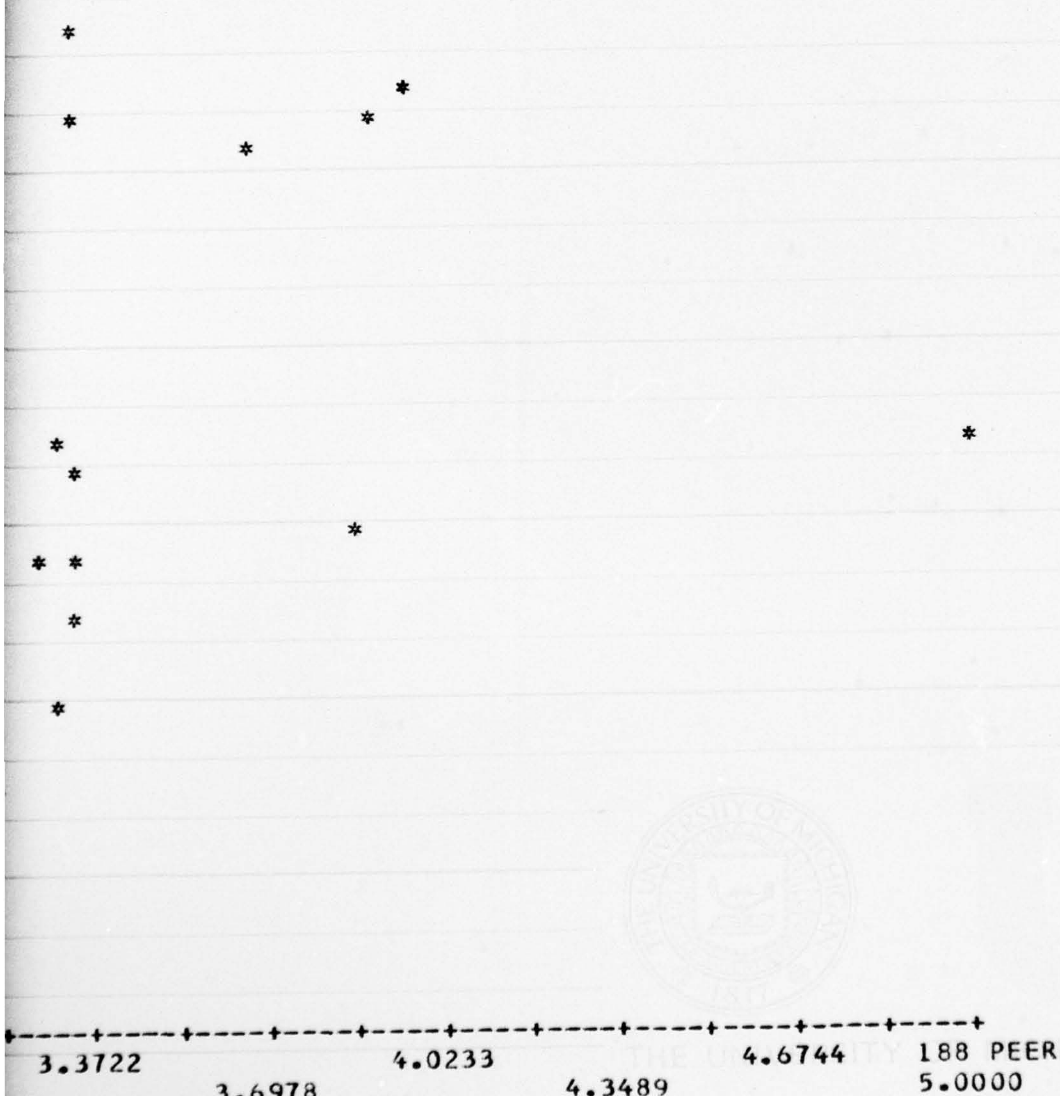

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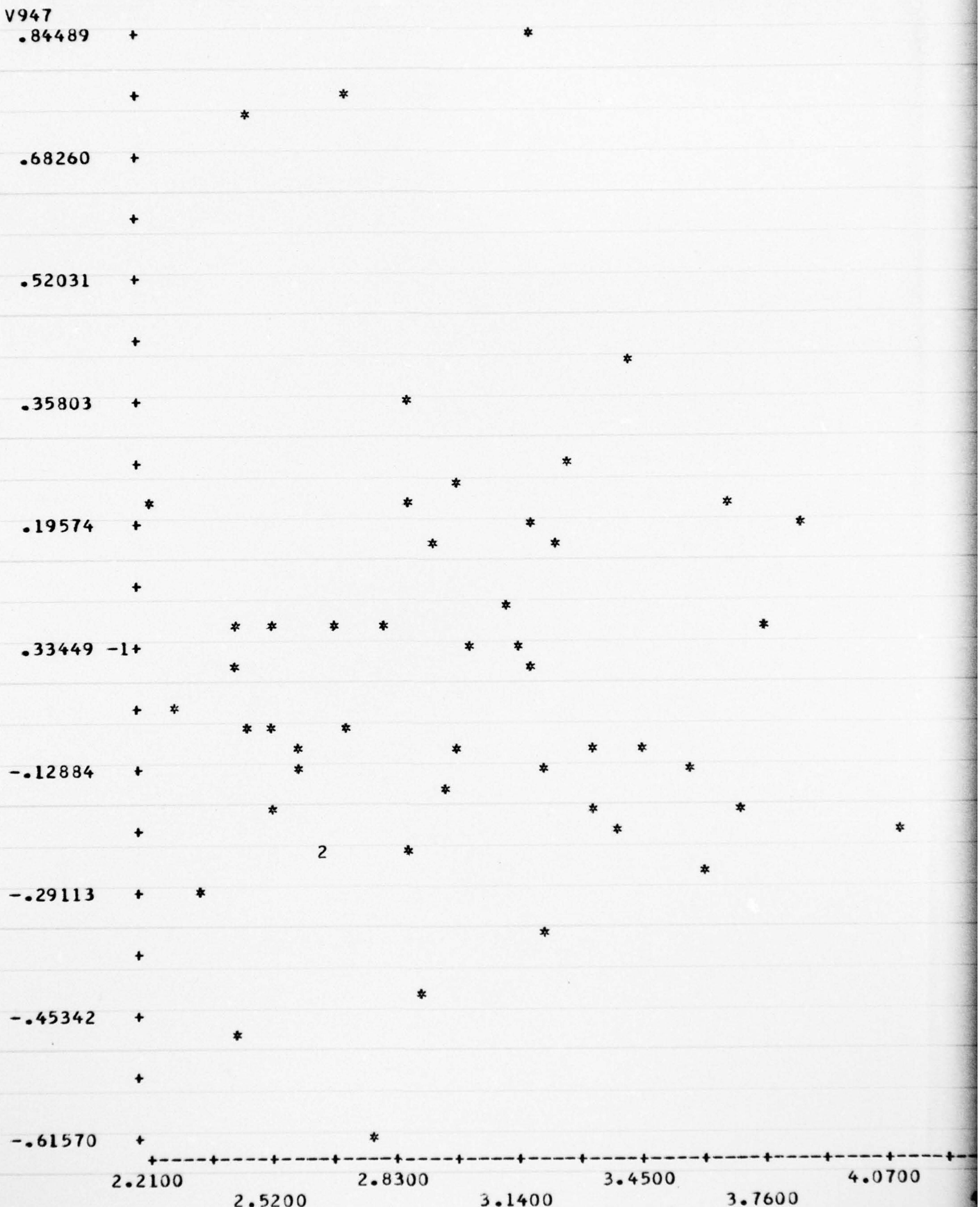

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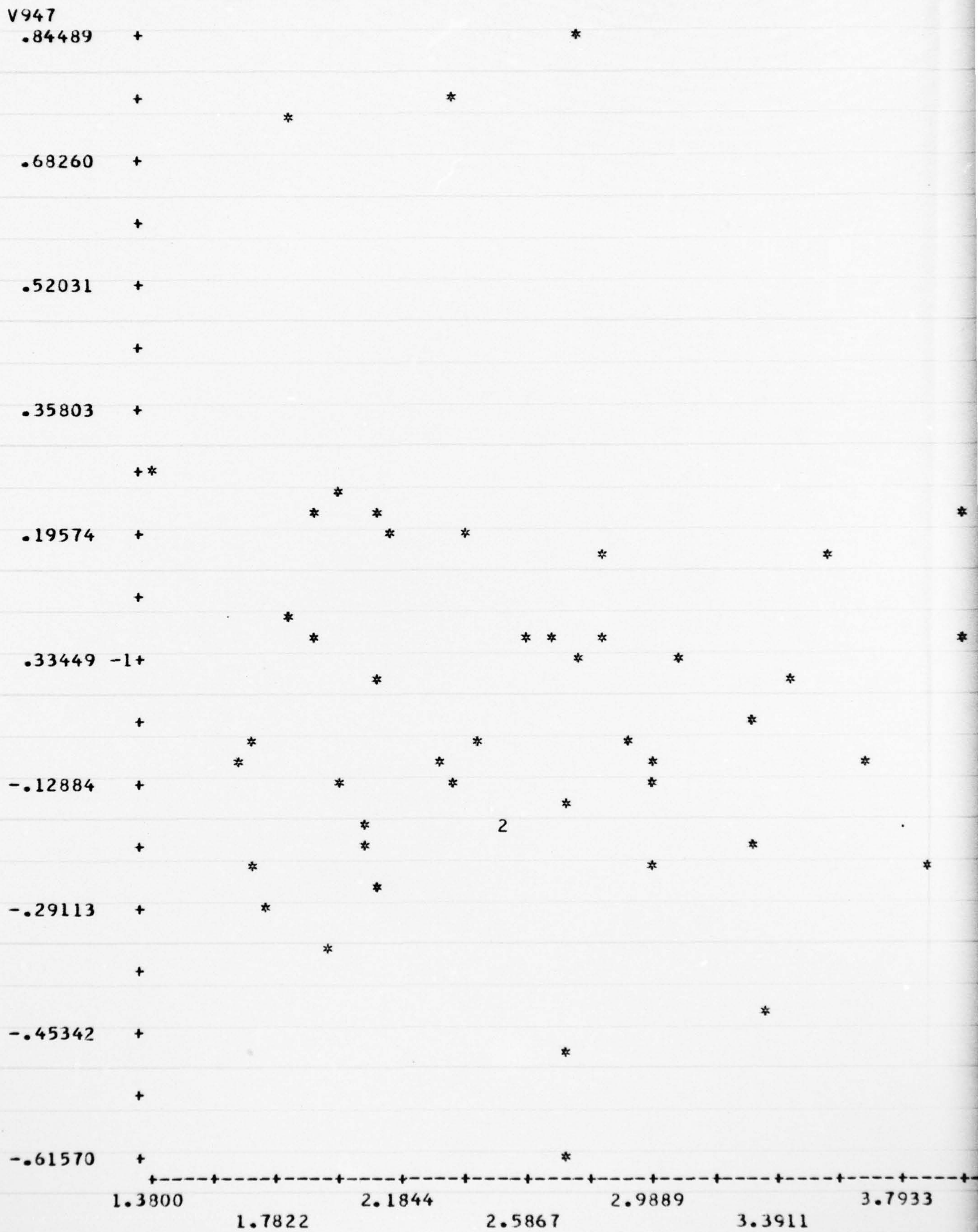

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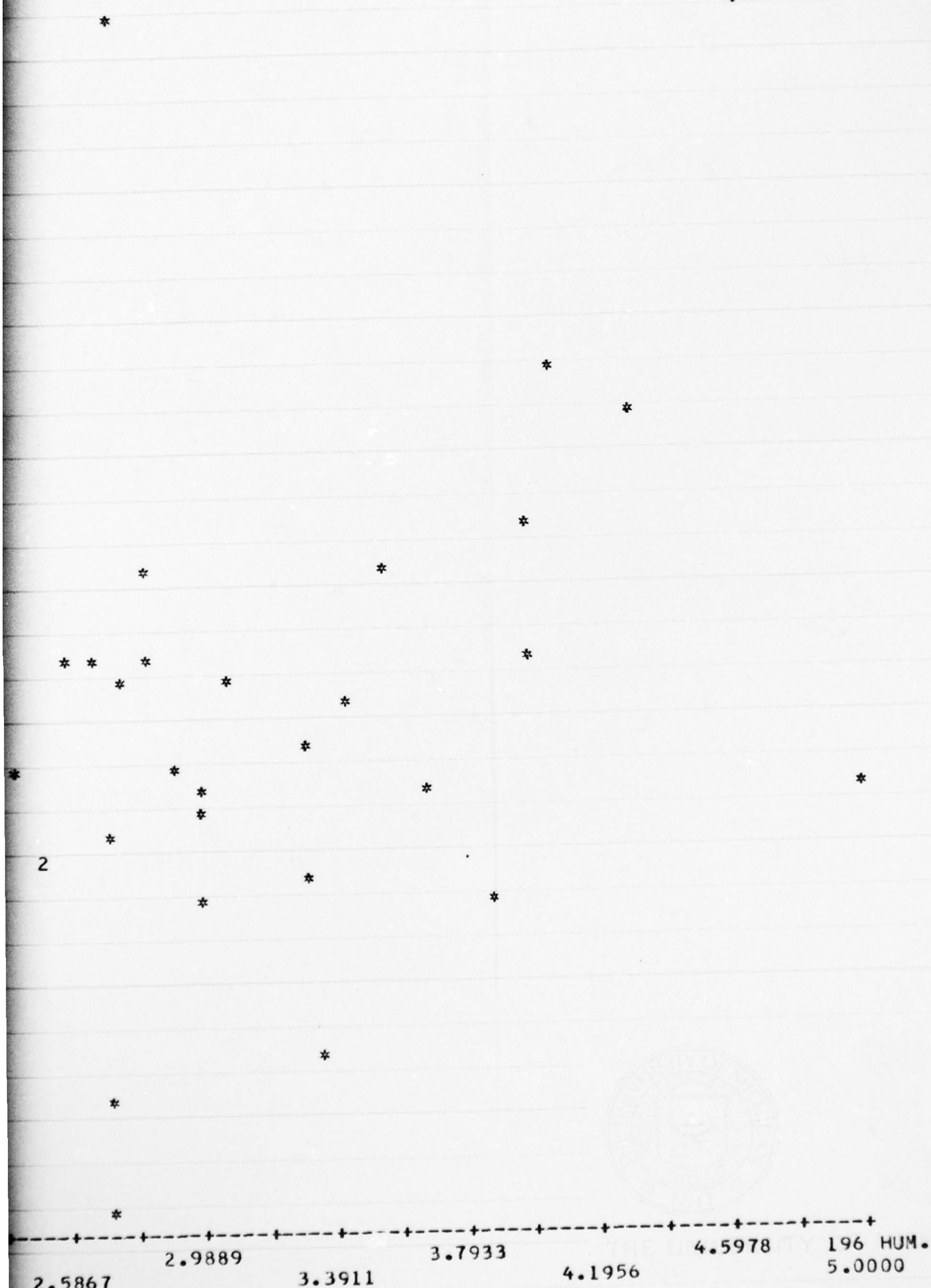

AD-A045 068 MICHIGAN UNIV ANN ARBOR INST FOR SOCIAL RESEARCH F/G 5/9
FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH T--ETC(U)
JUN 77 A S DAVENPORT, J B LAPOINTE N00014-76-C-0362

UNCLASSIFIED NL

4 OF 7
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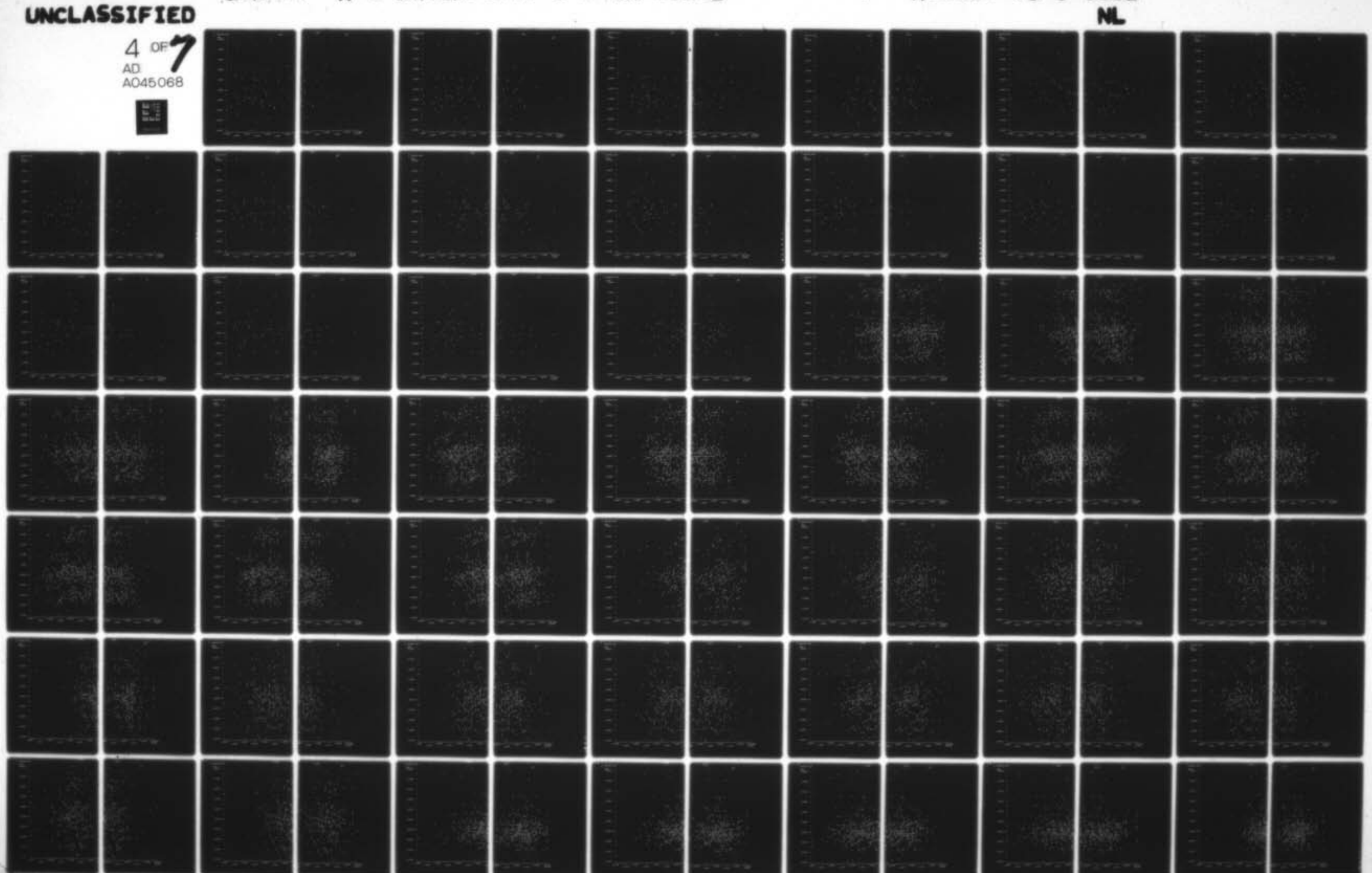

OF 7

068

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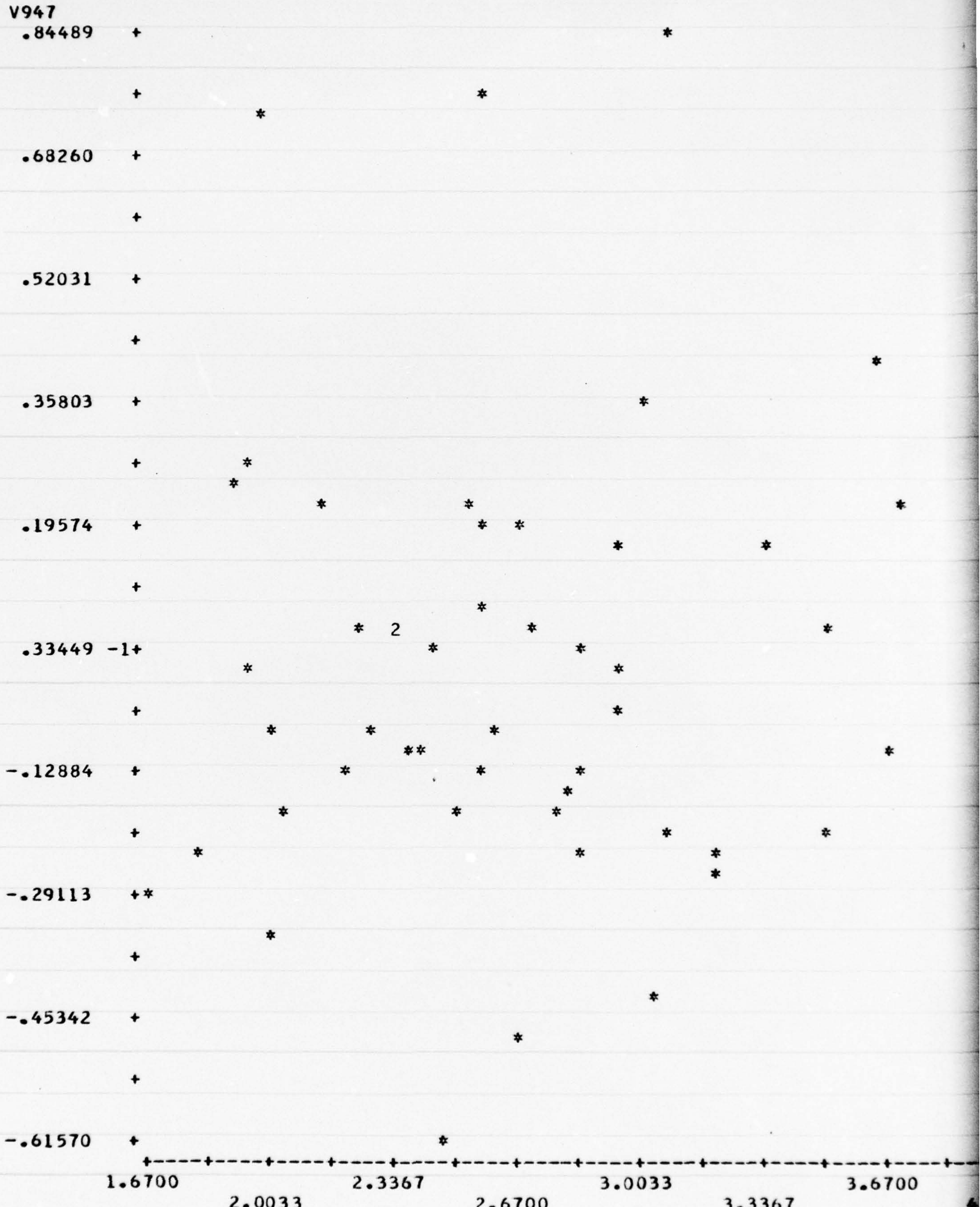

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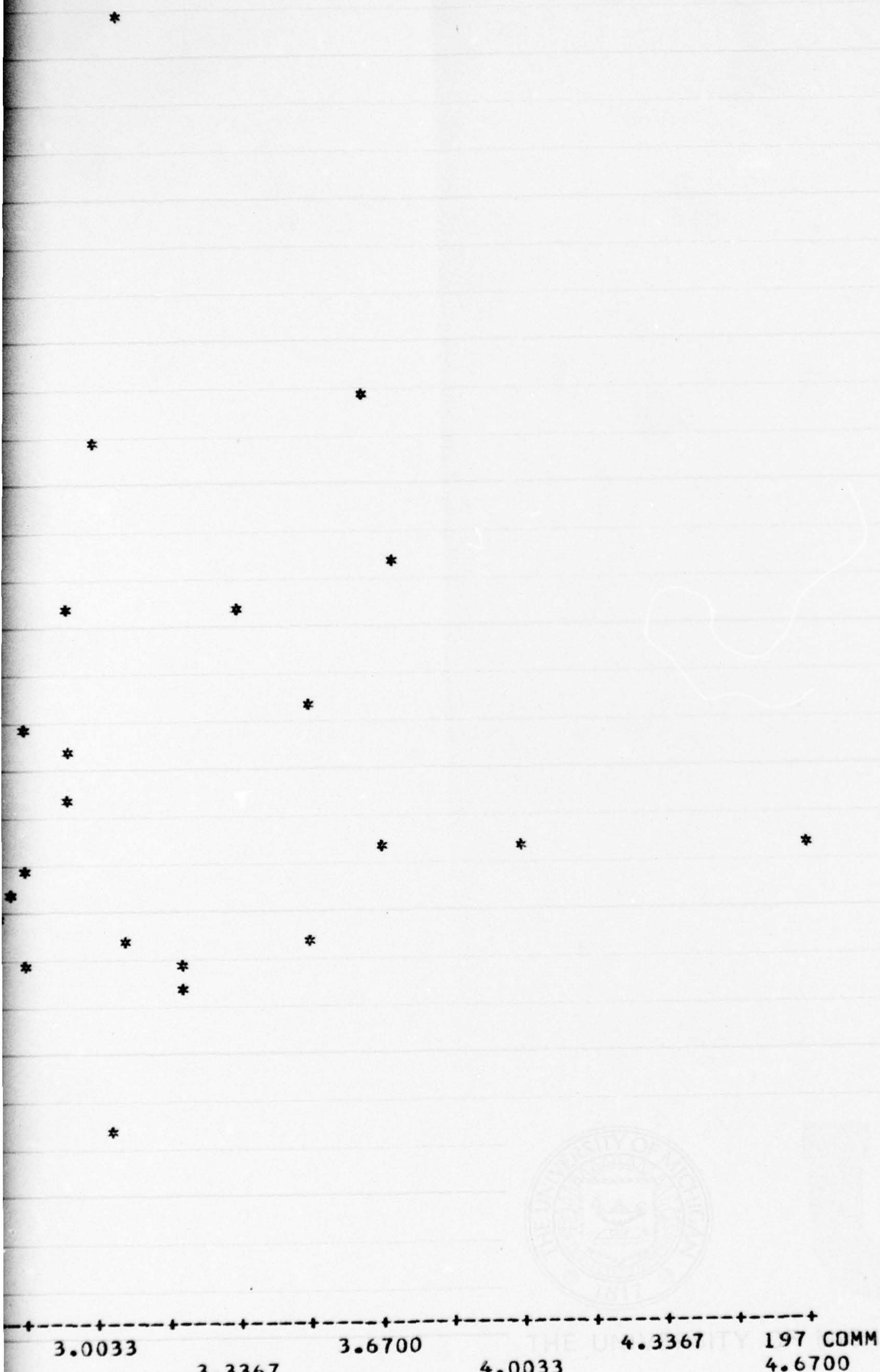

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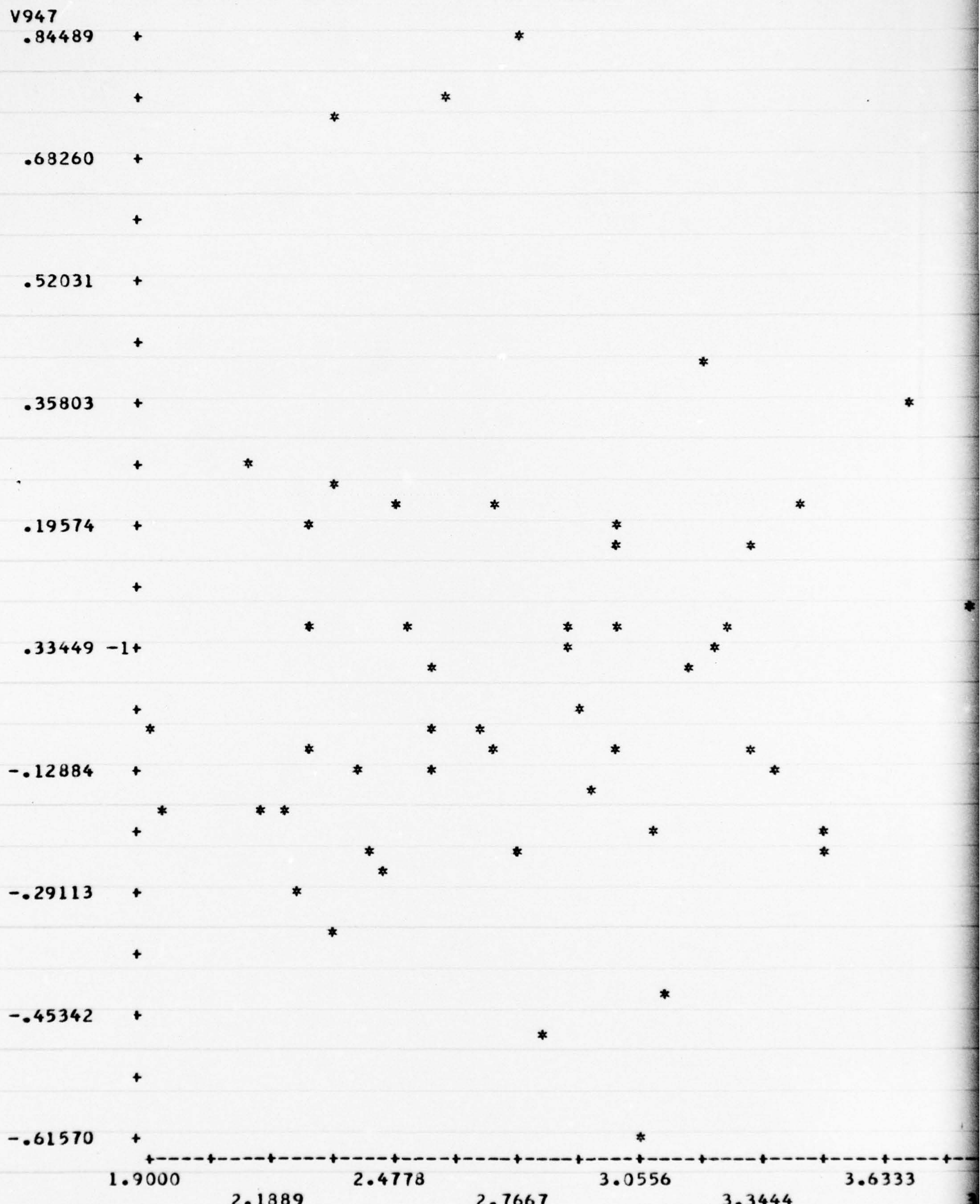

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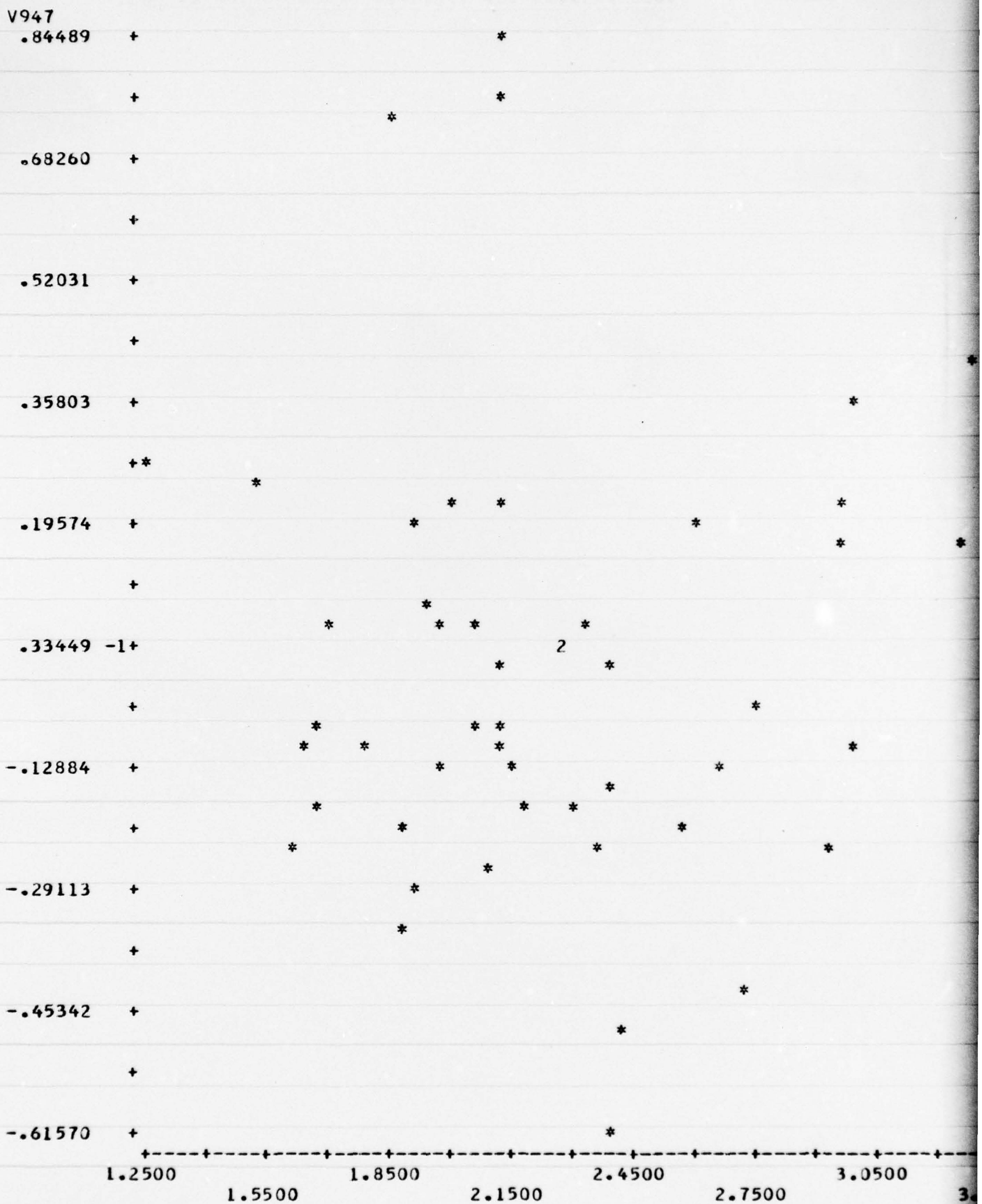

B-92

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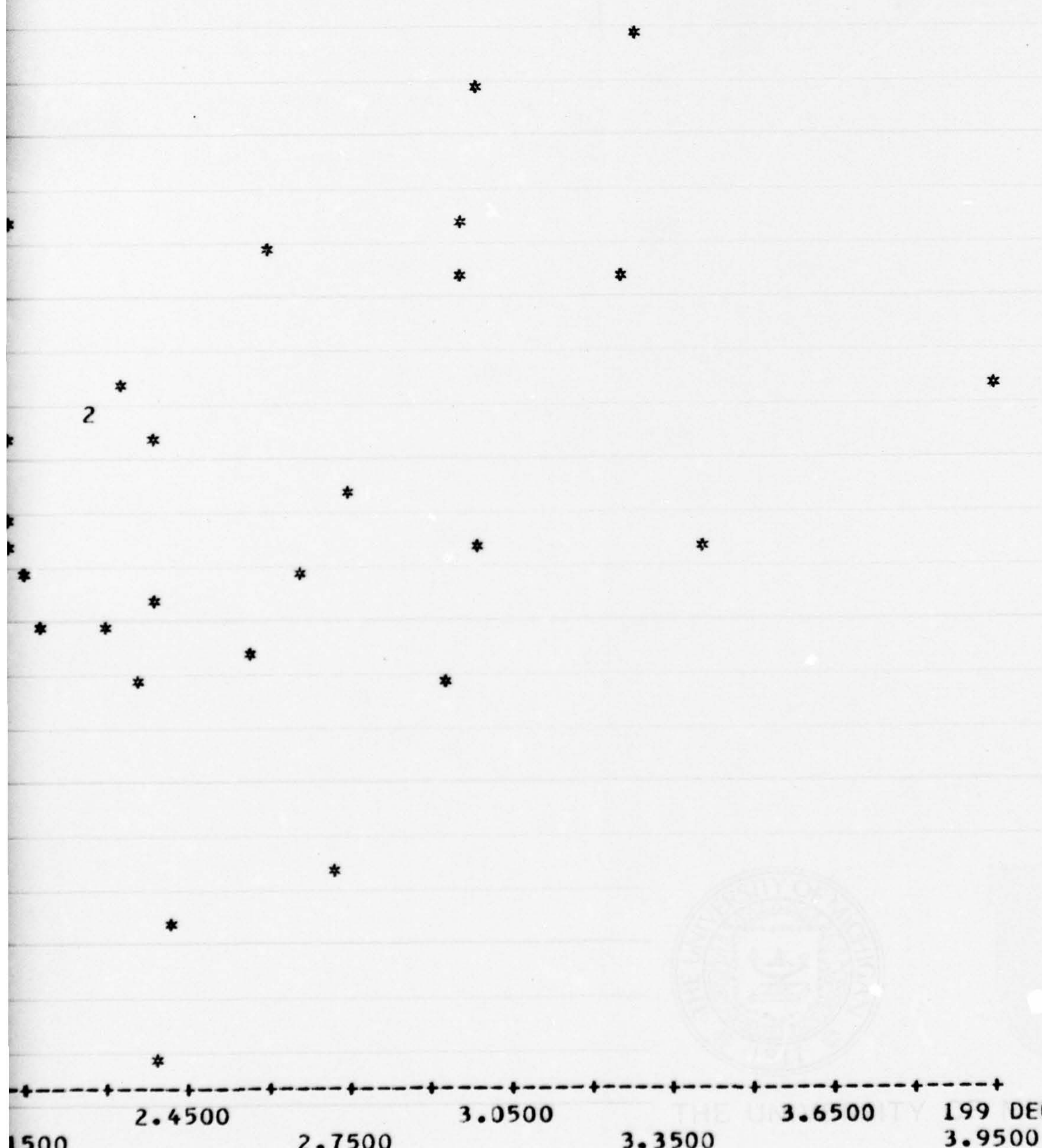

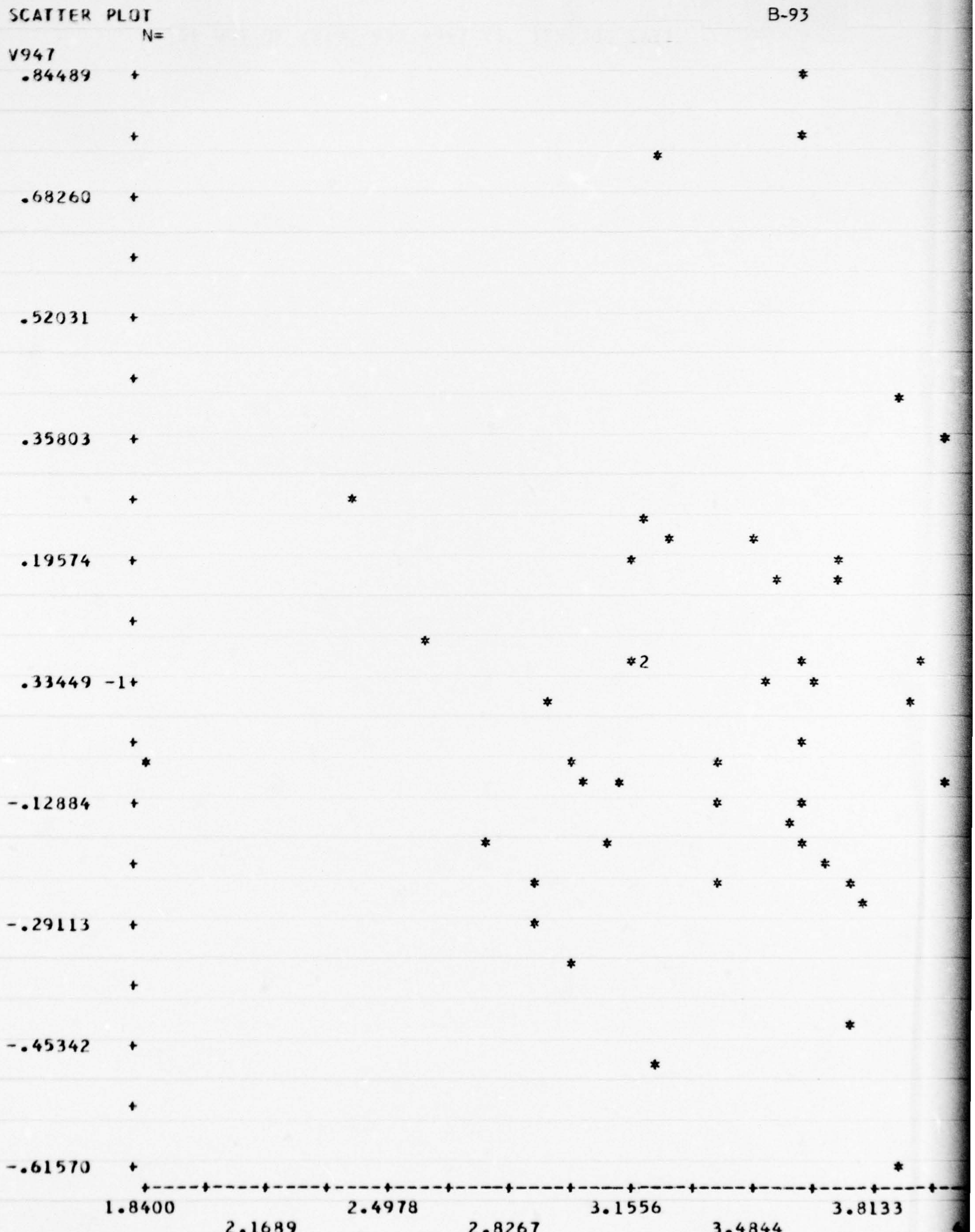
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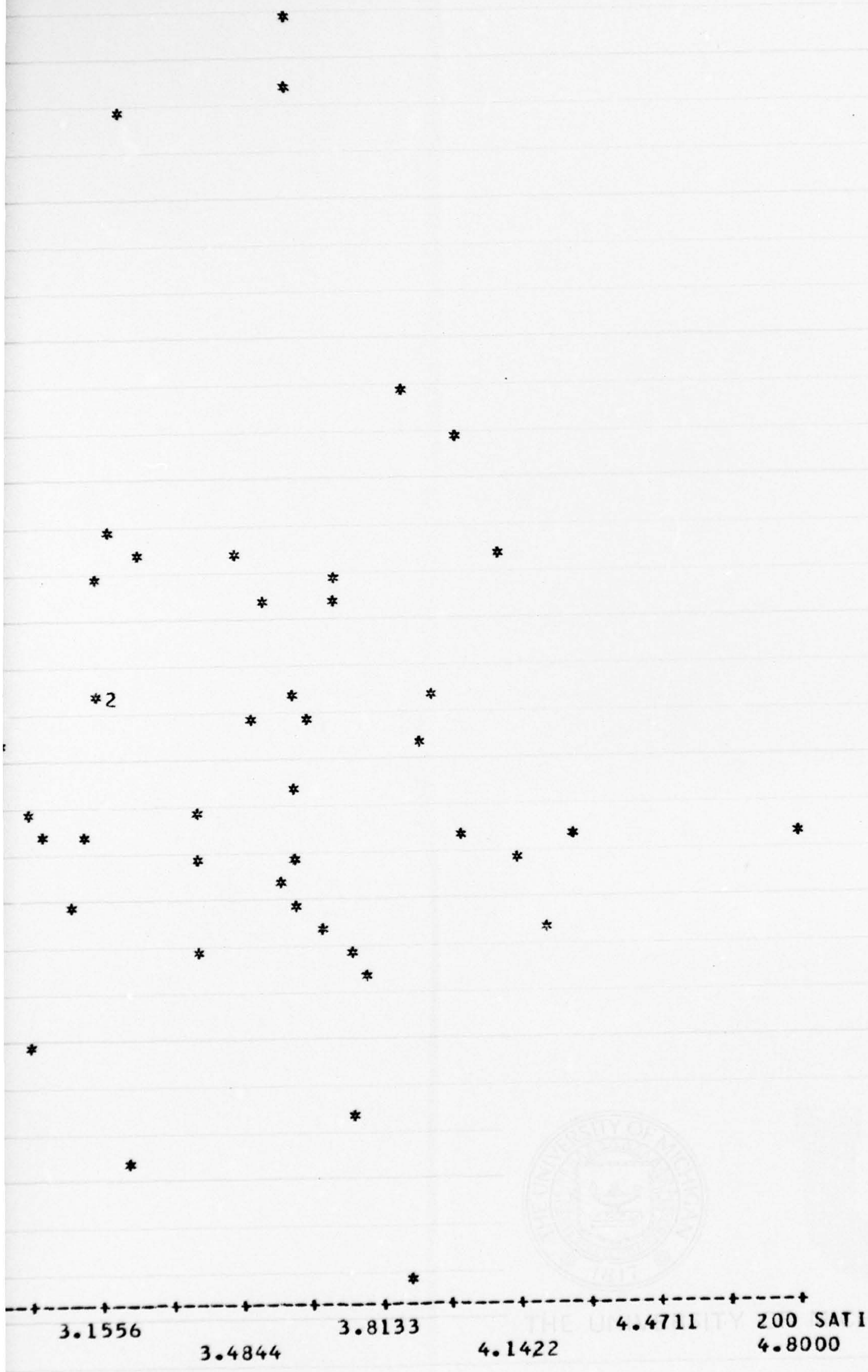
.19574
.33449 -1
-.12884
-.29113
-.45342
-.61570
*2
1.8400
2.1689
2.4978
2.8267
3.1556
3.4844
3.8133

B-93

2



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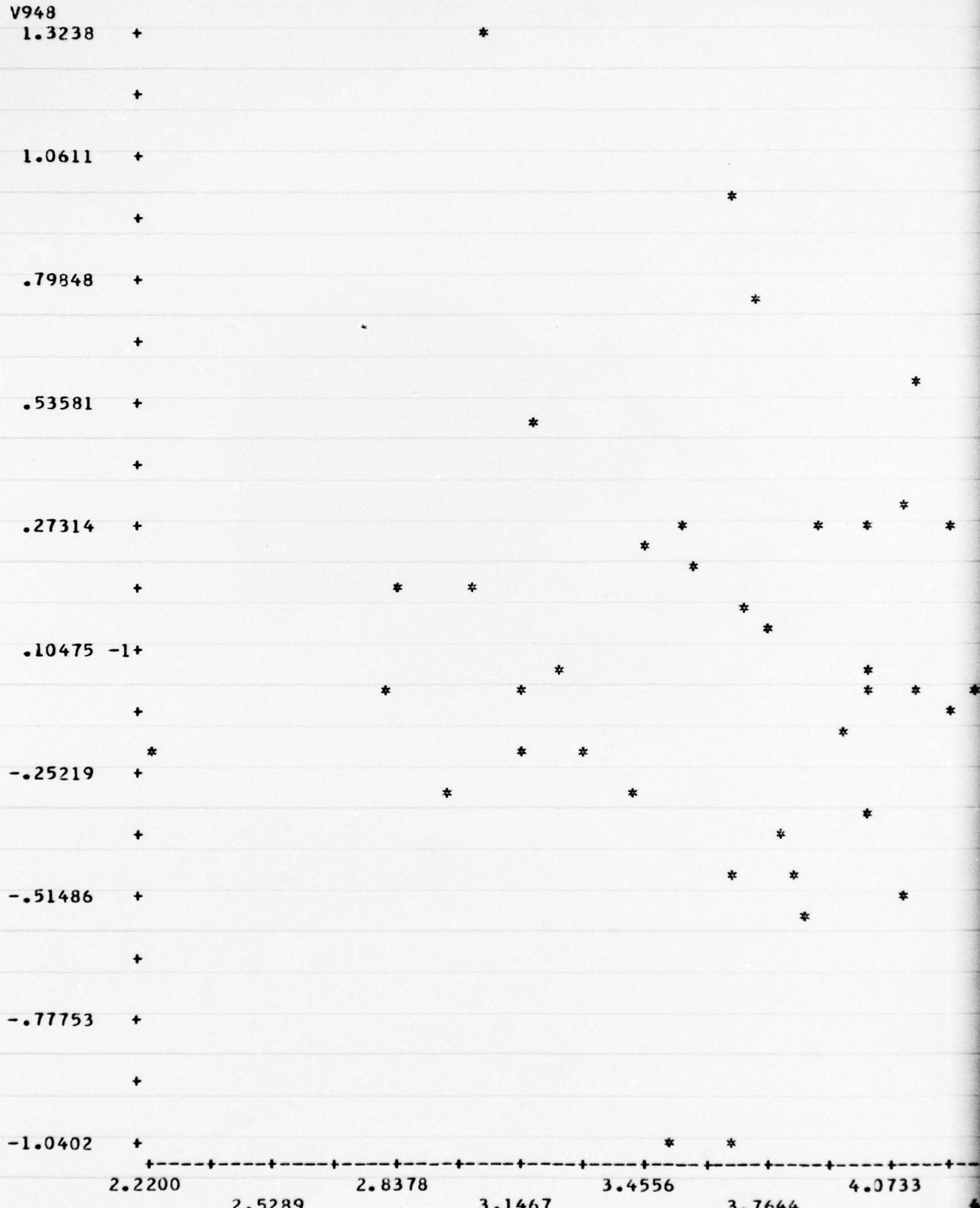

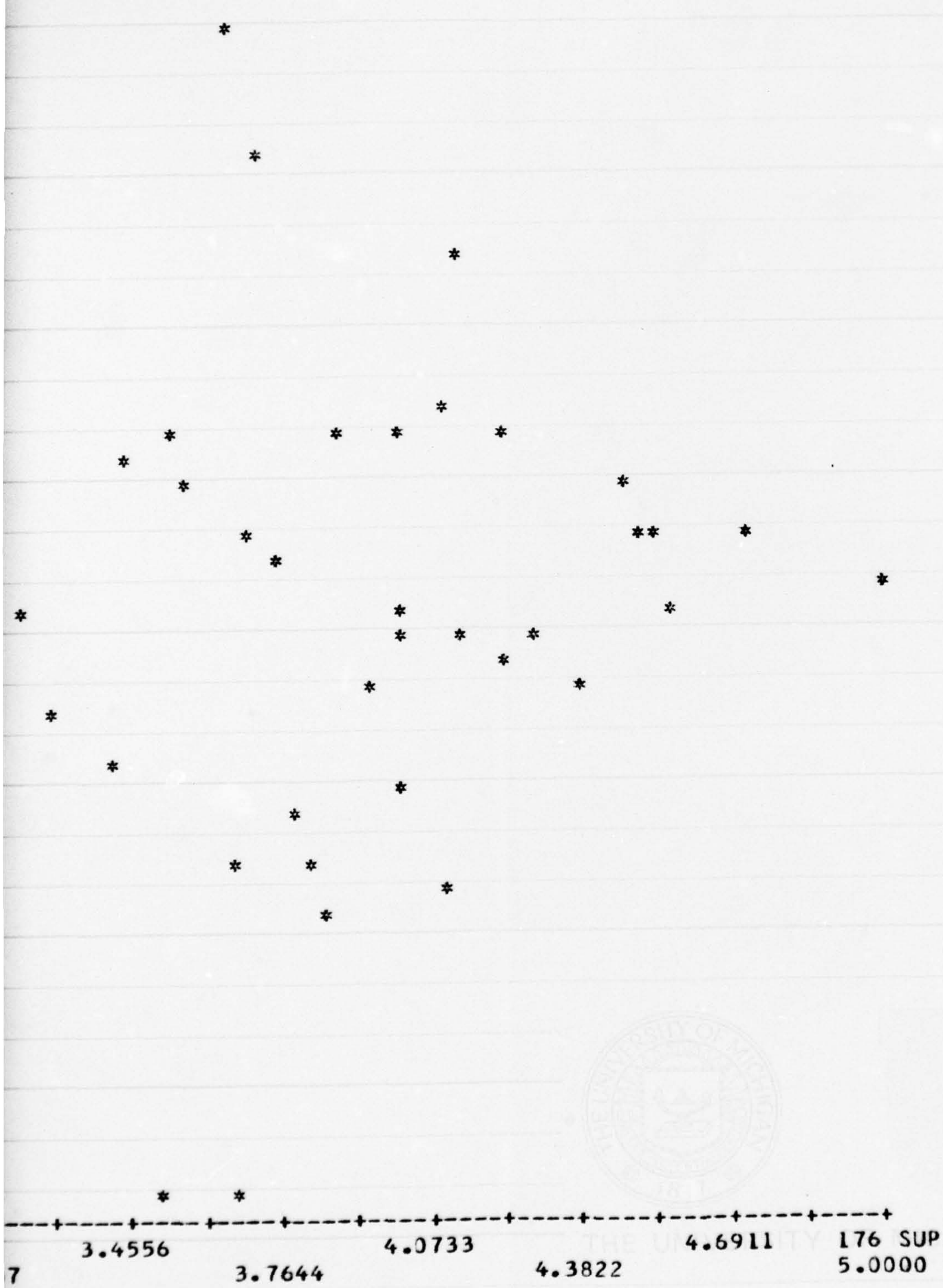
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176 SUP
7
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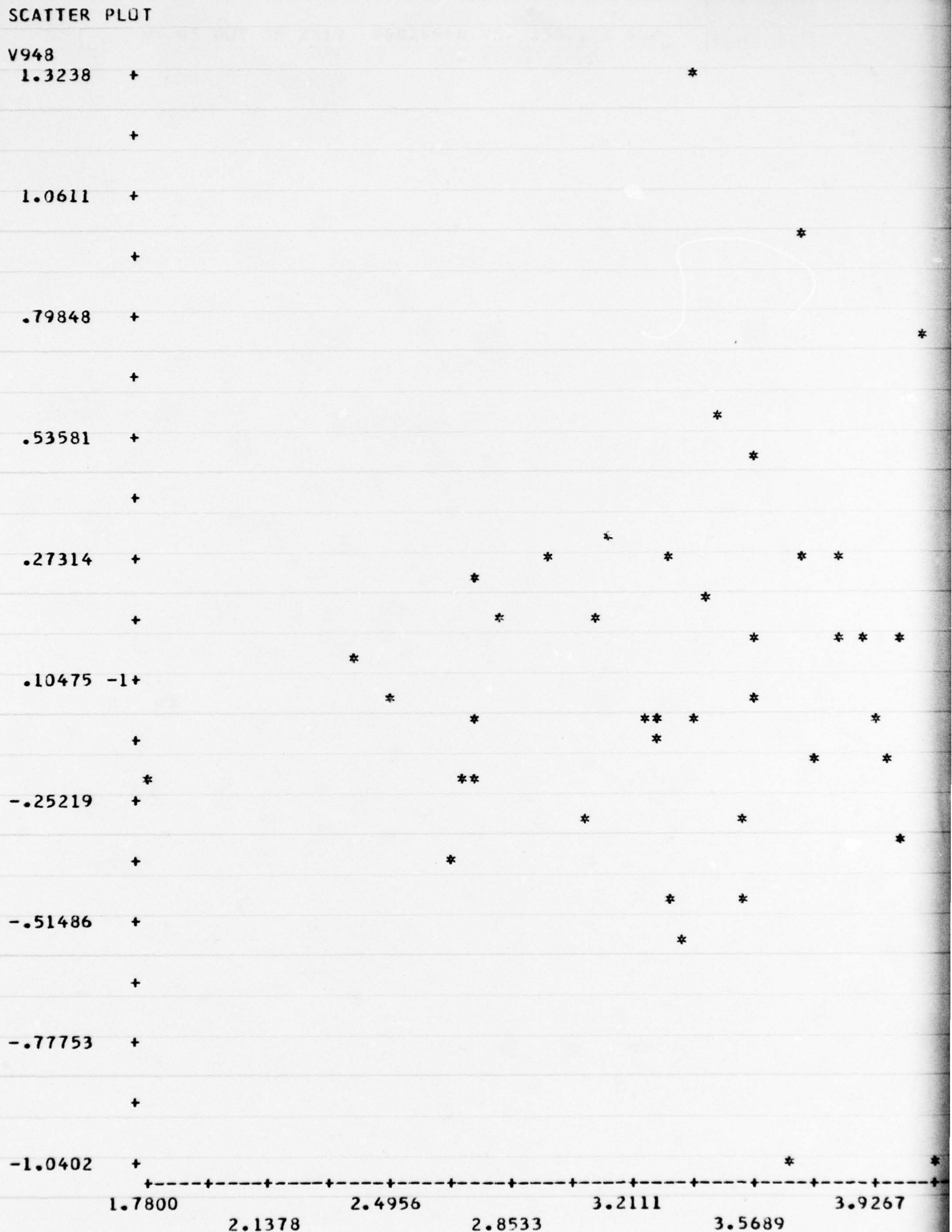
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2

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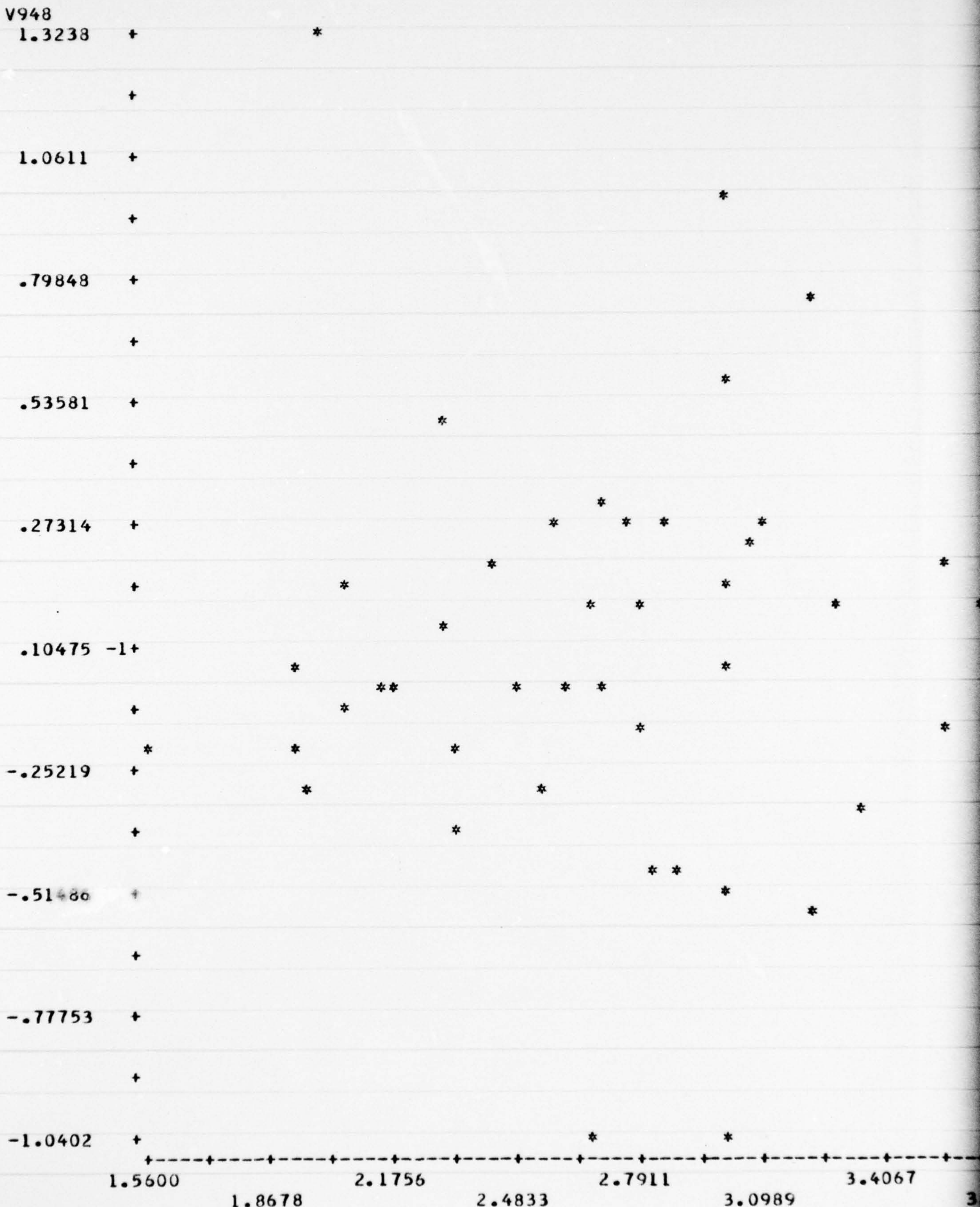

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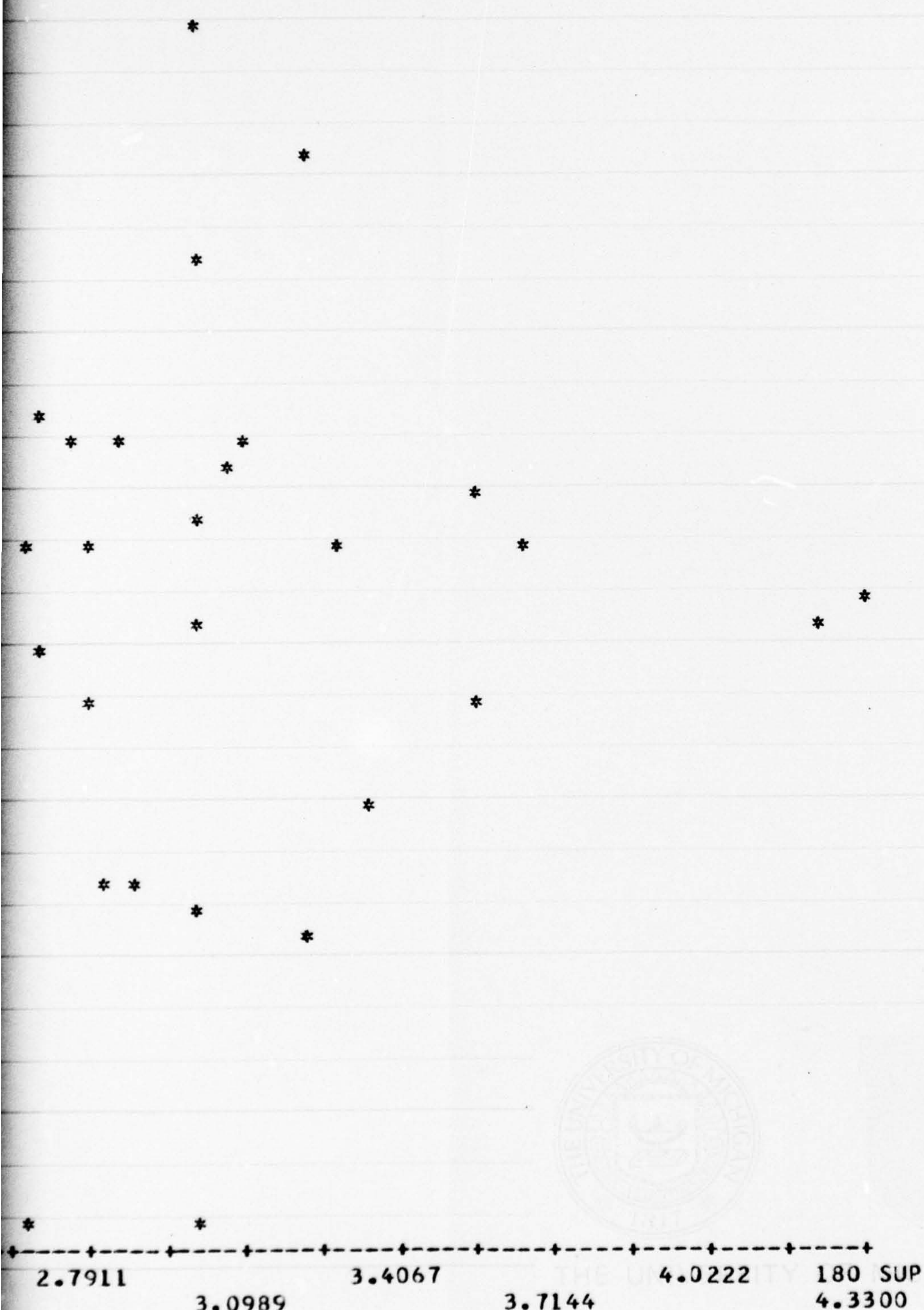

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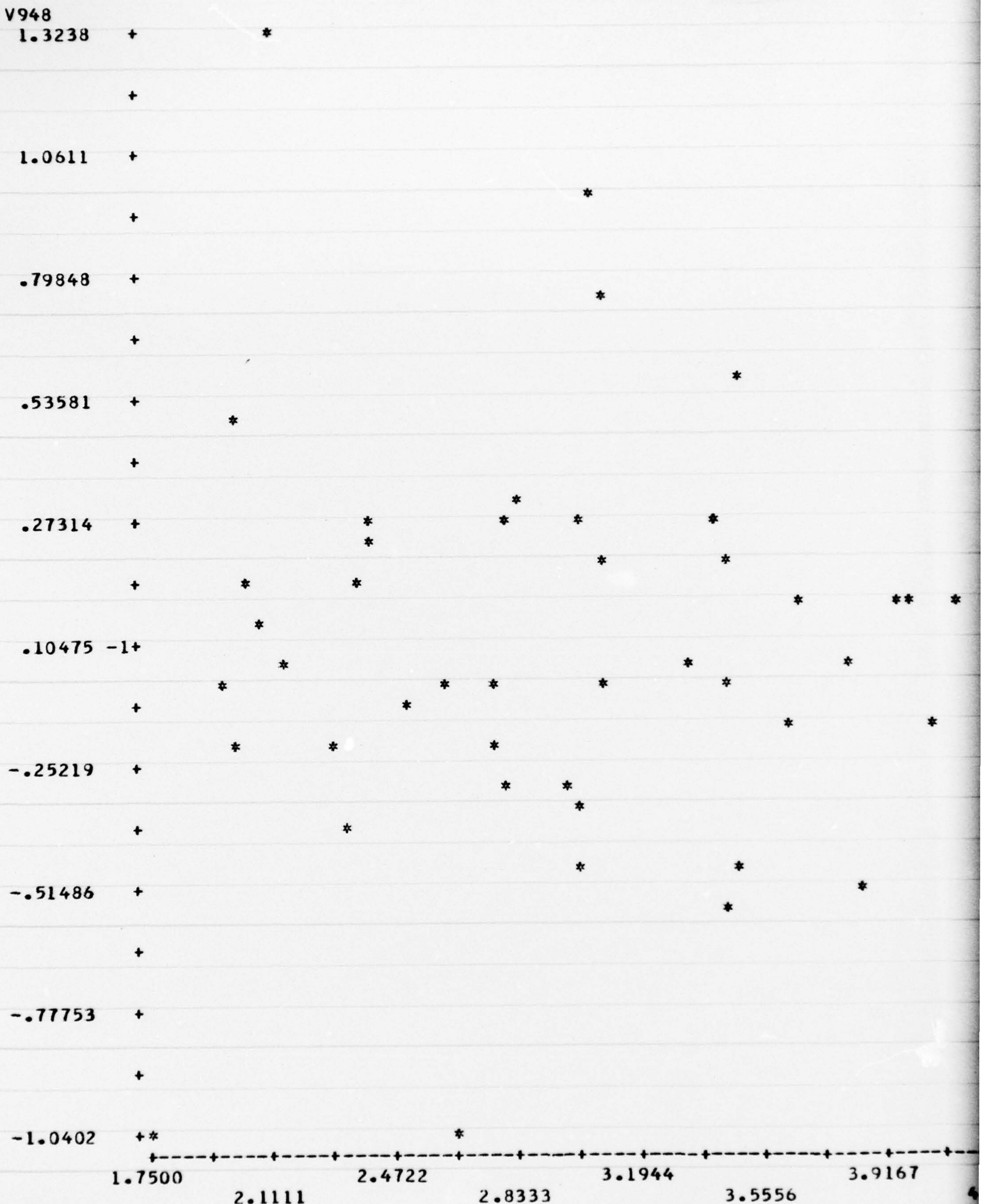

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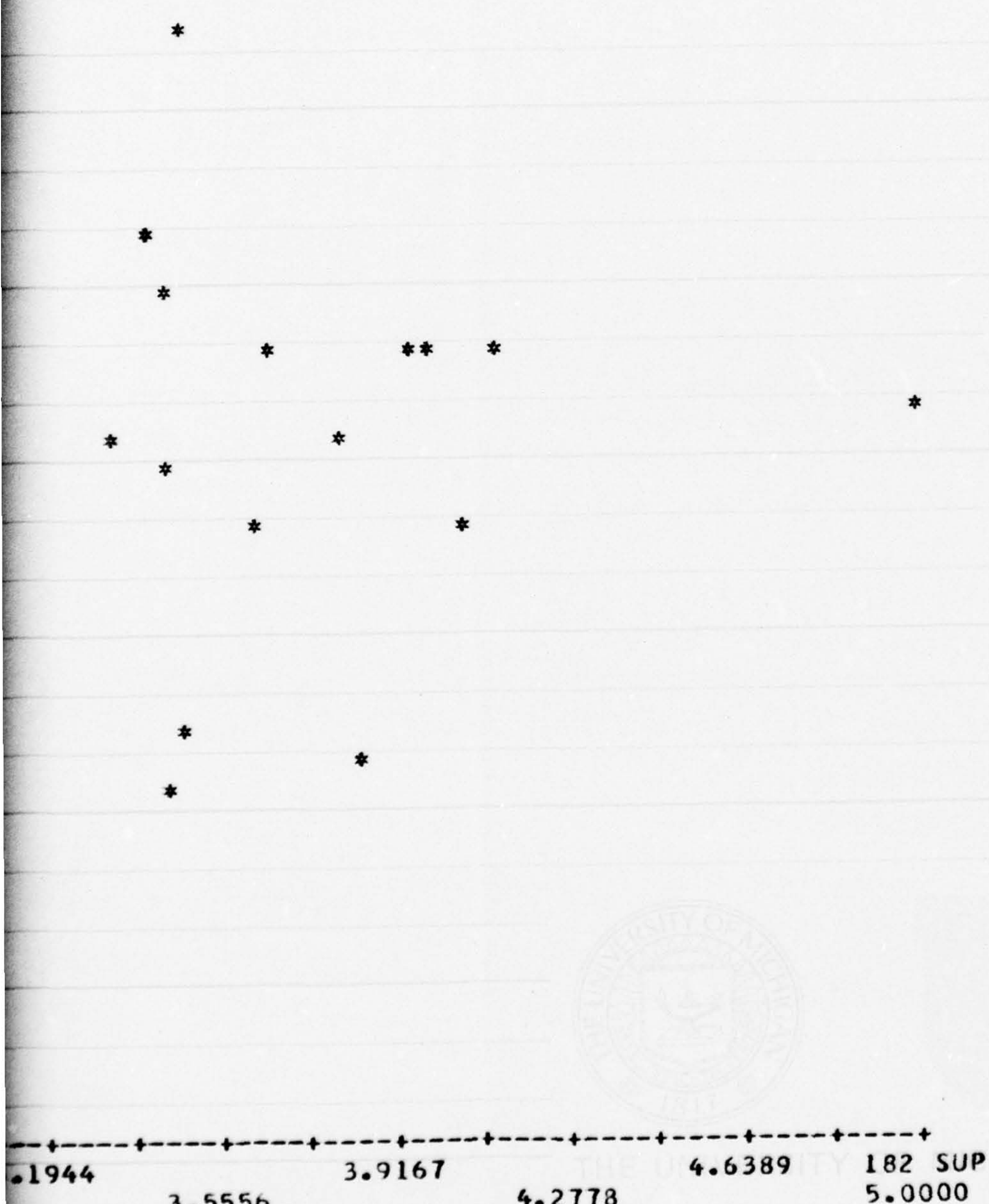

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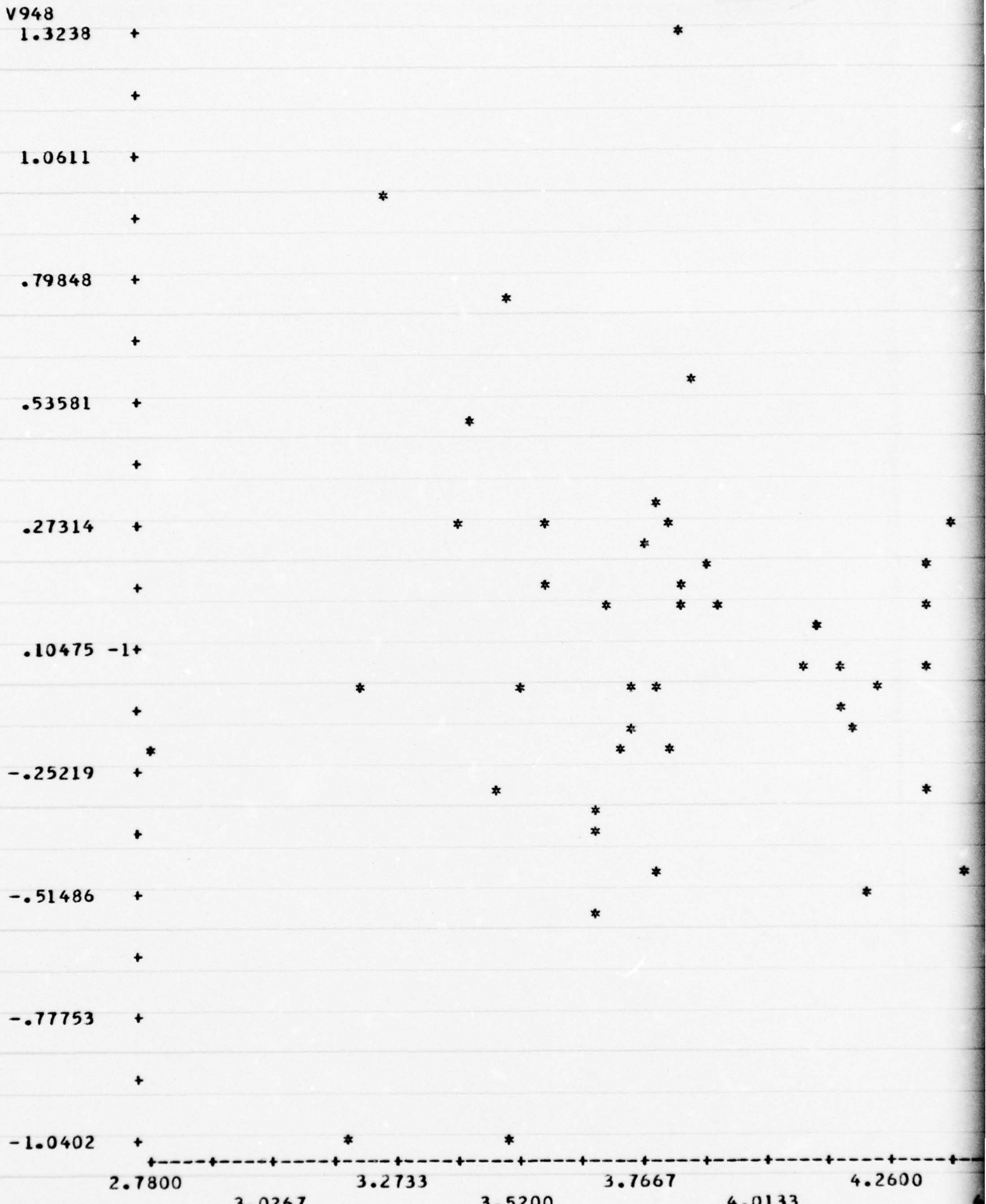
SCATTER PLOT



B-98

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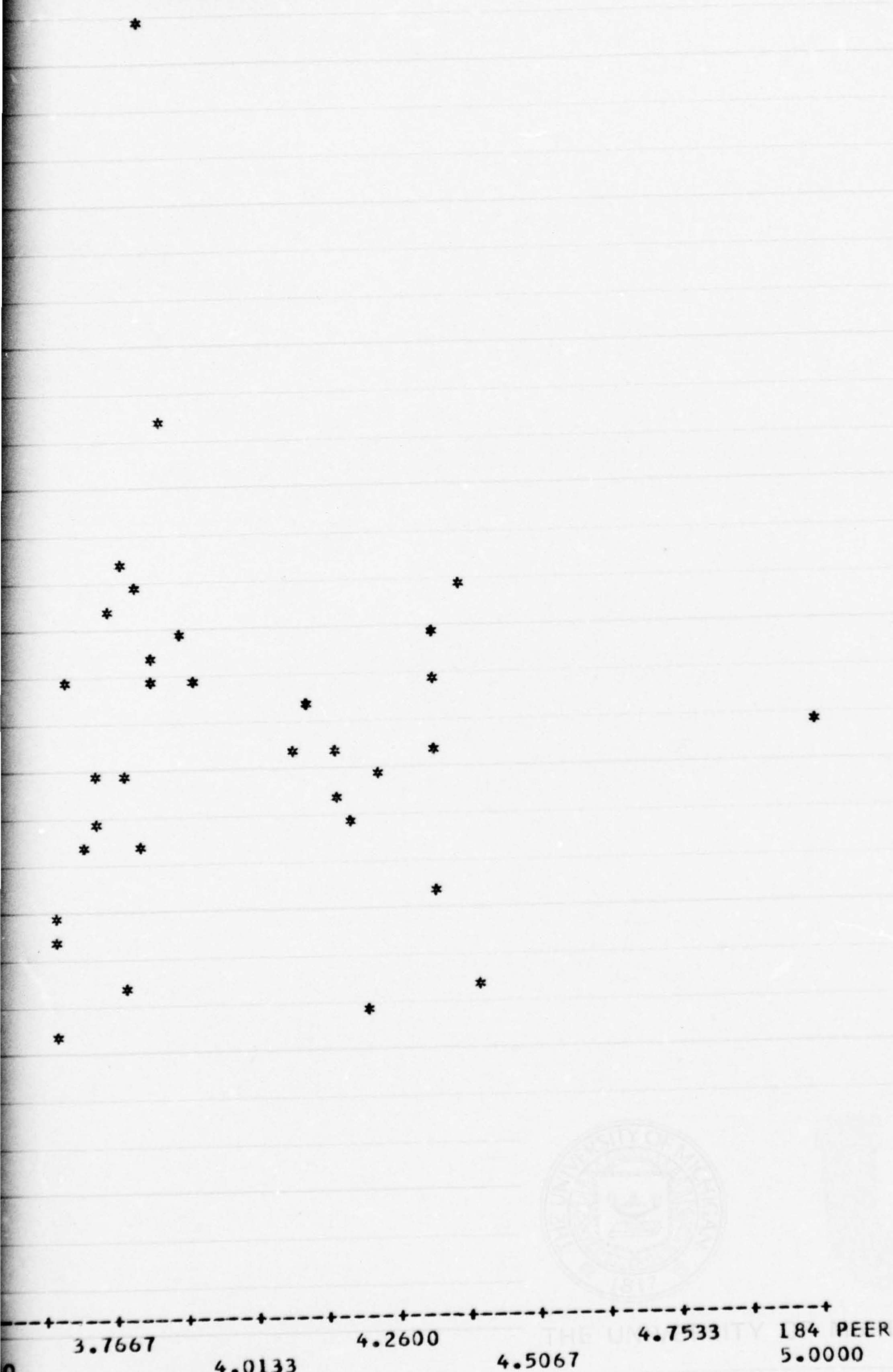

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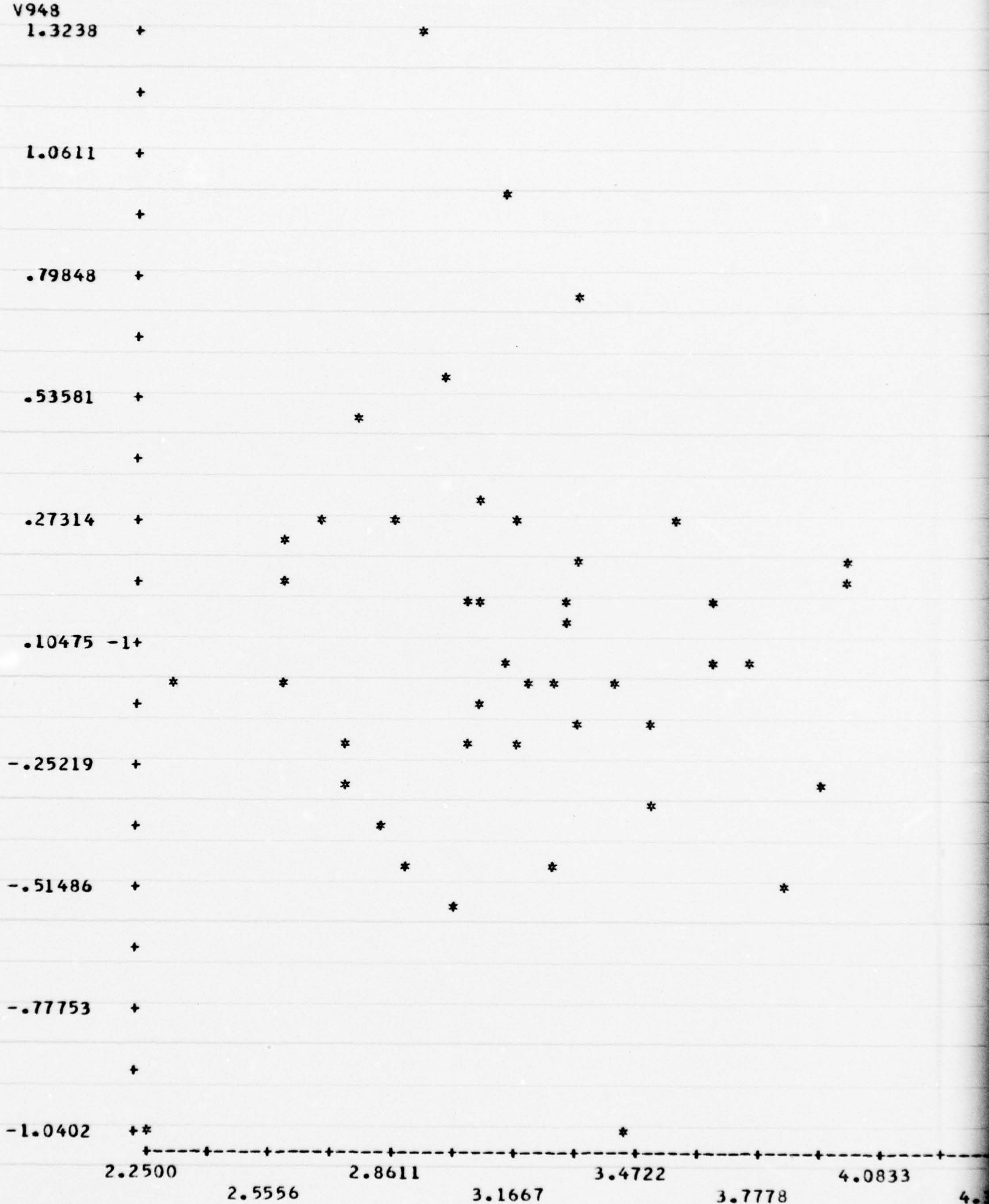

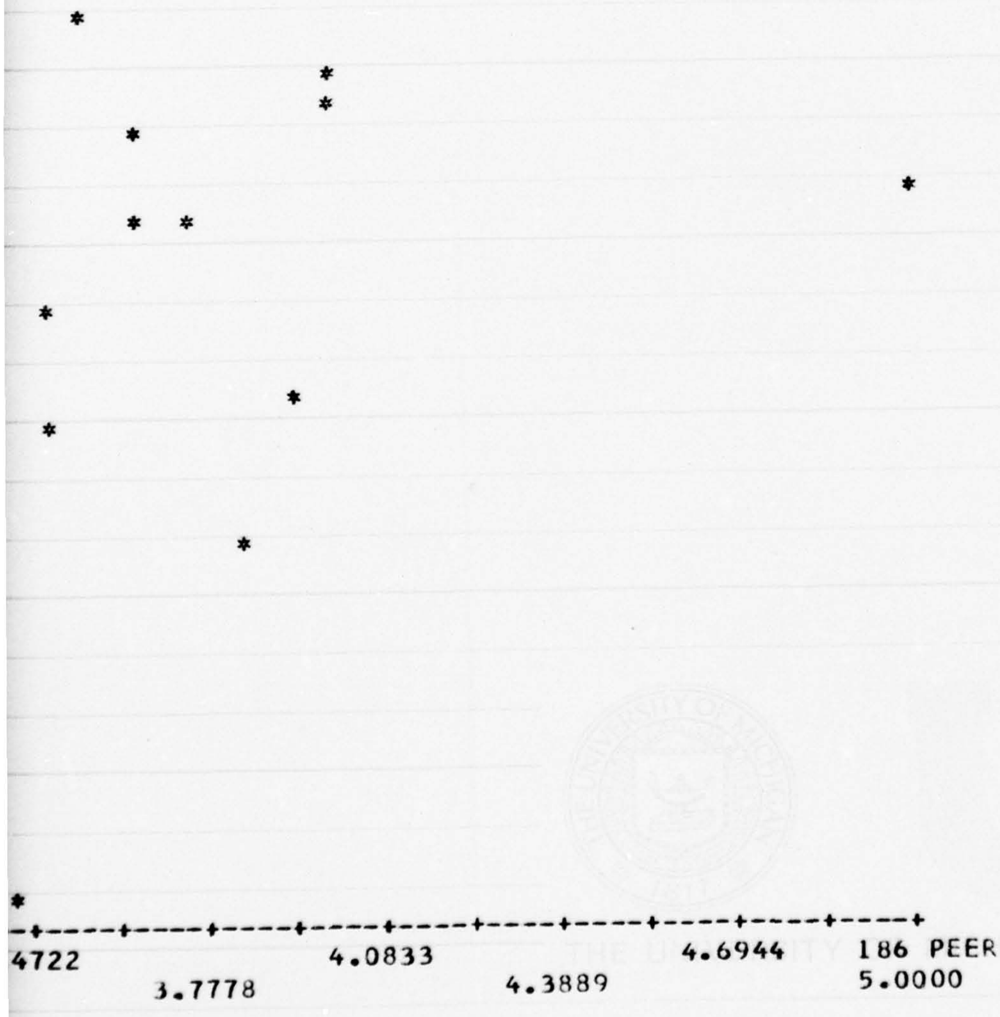
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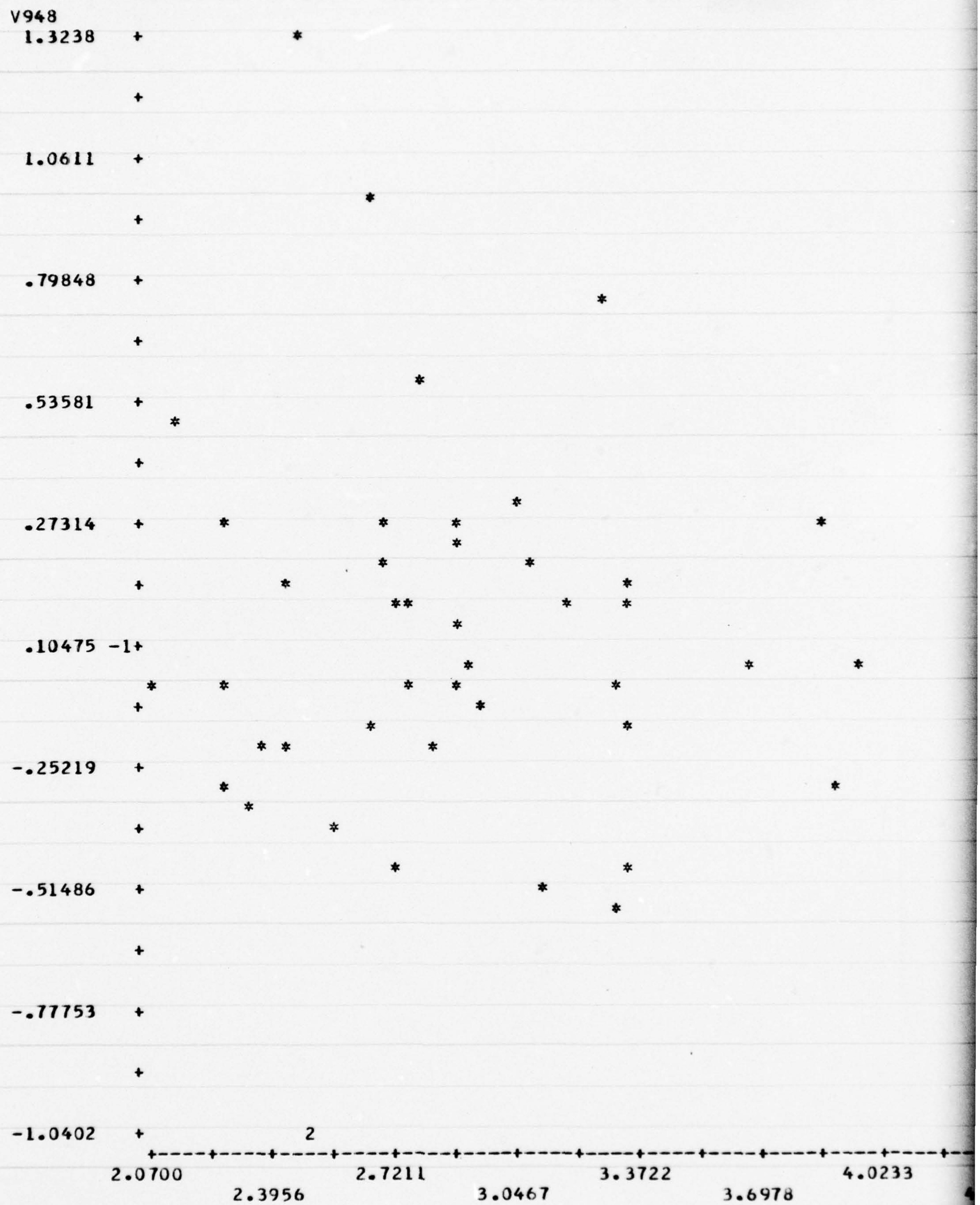
4.6944
186 PEER
5.0000

SCATTER PLOT



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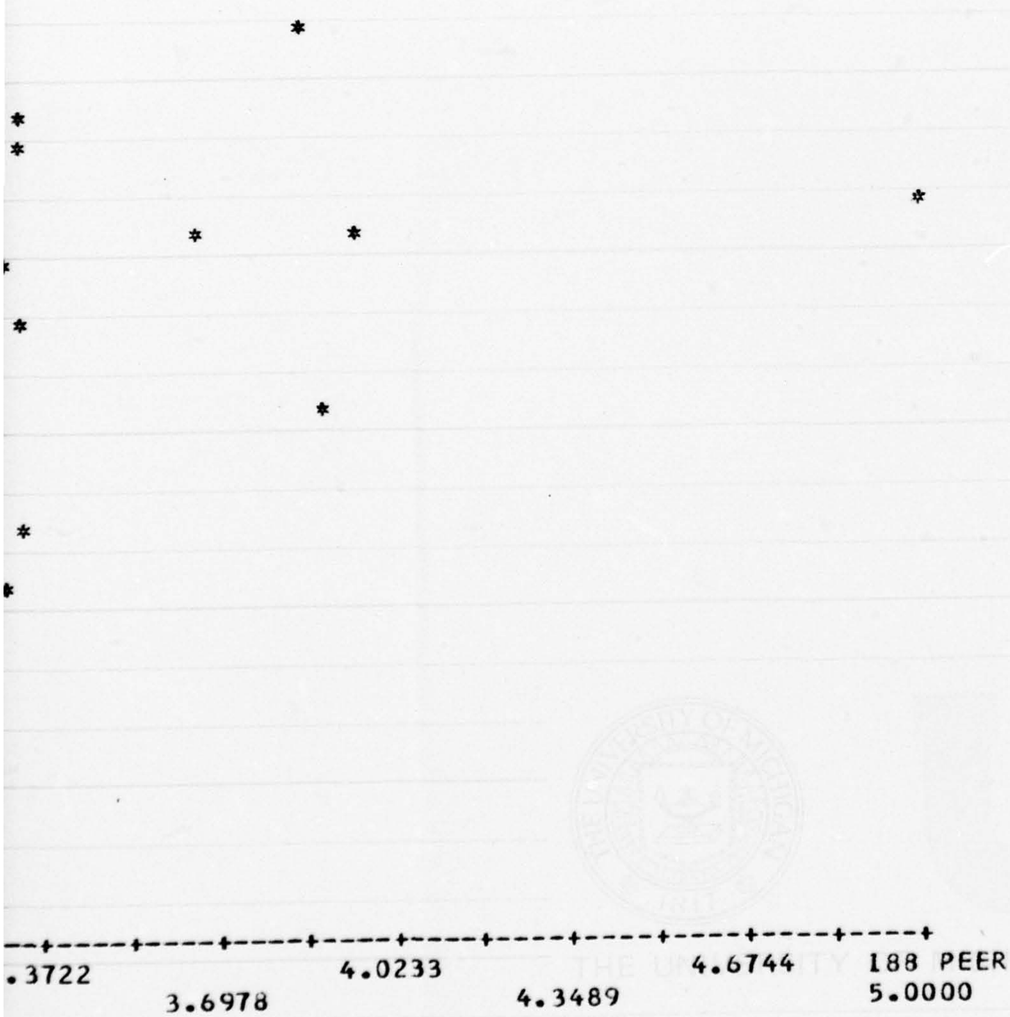

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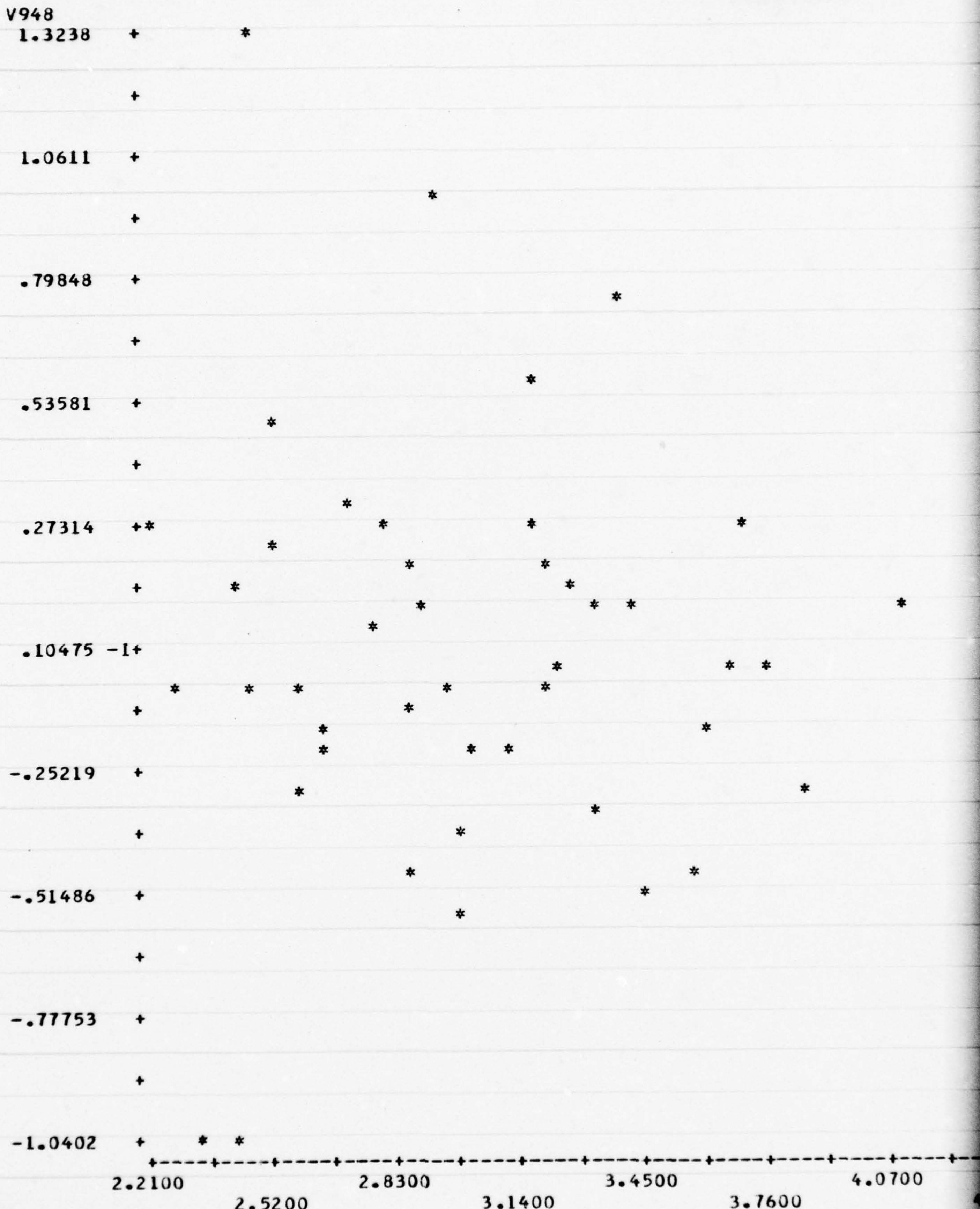
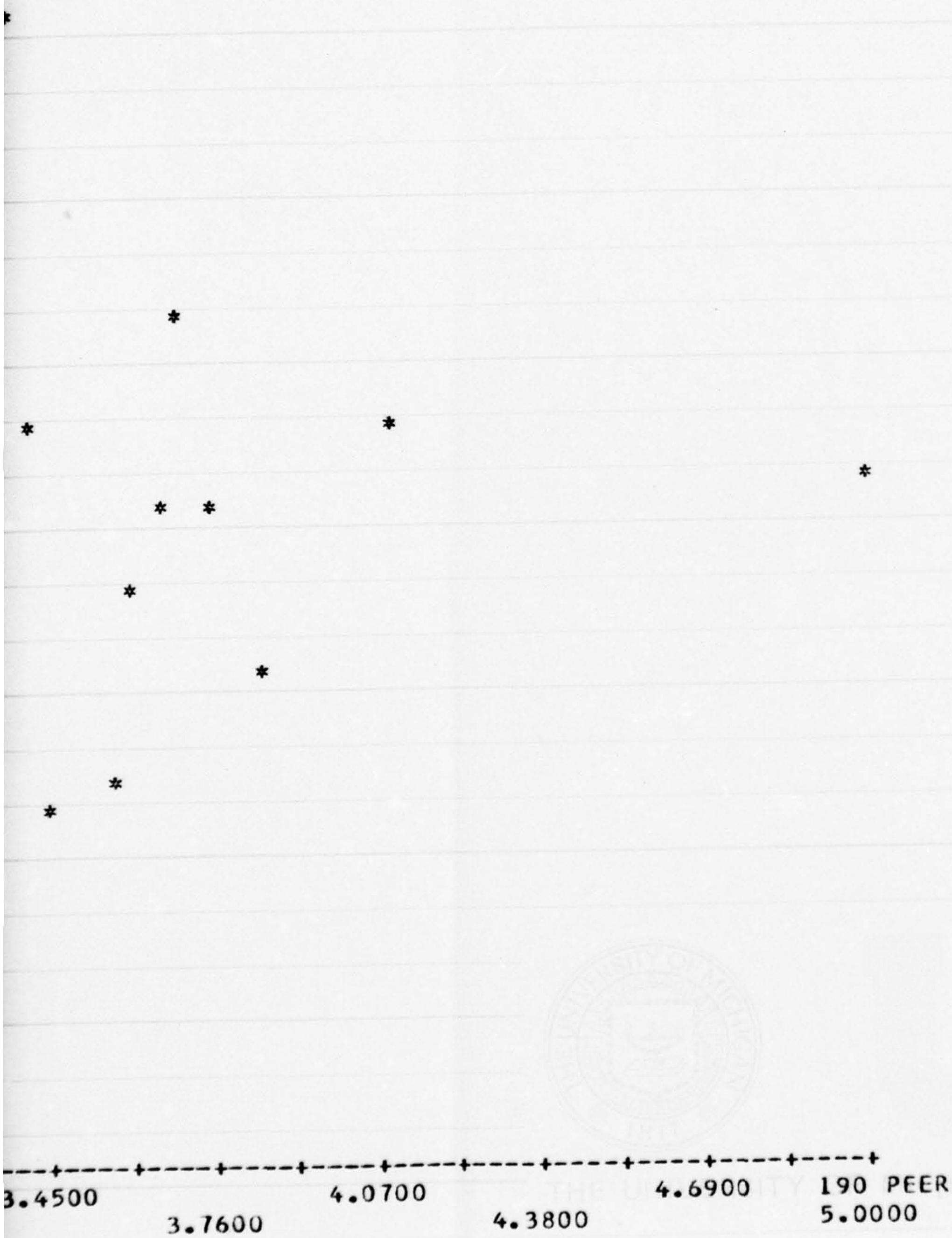


B-101

1 2



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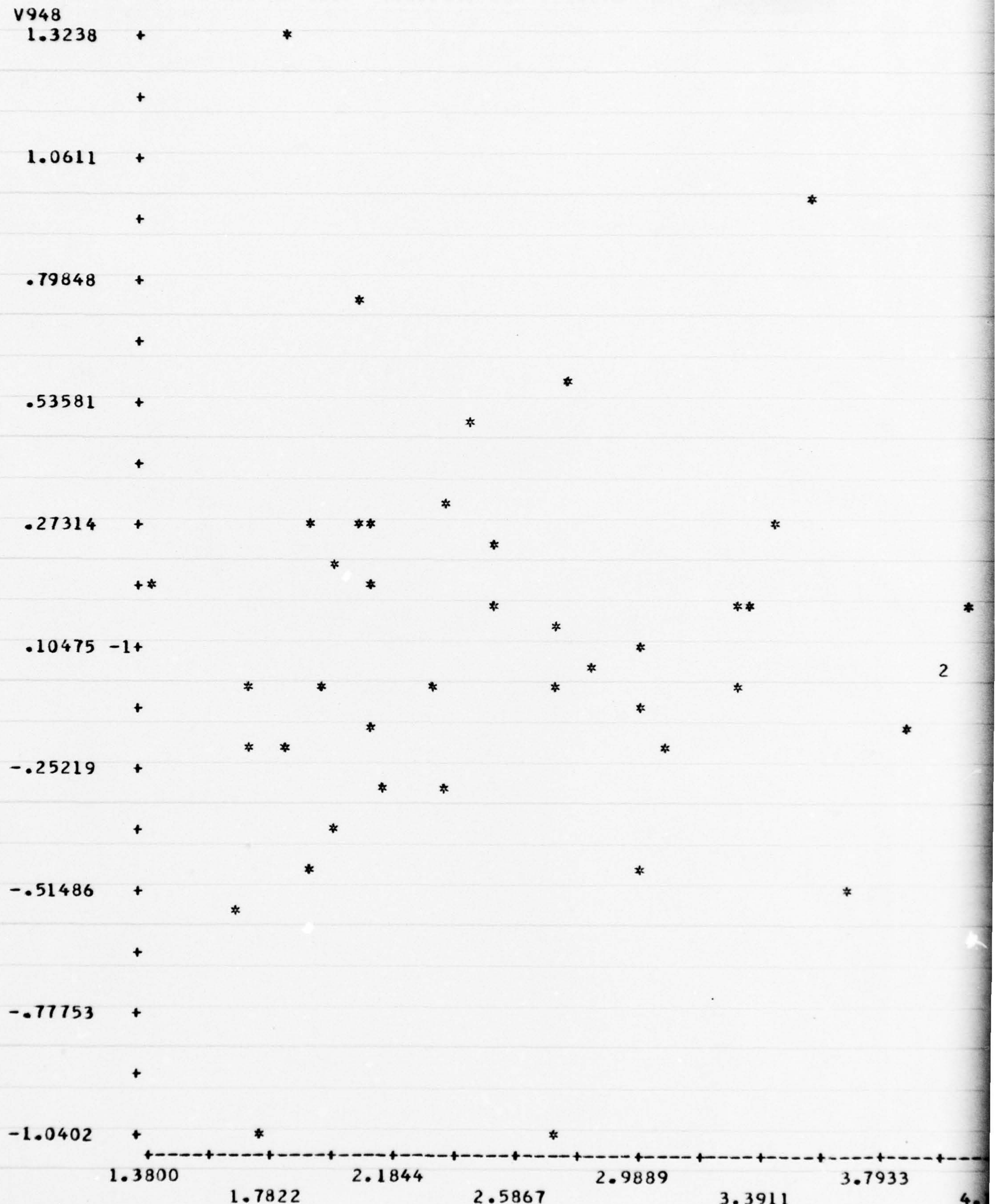
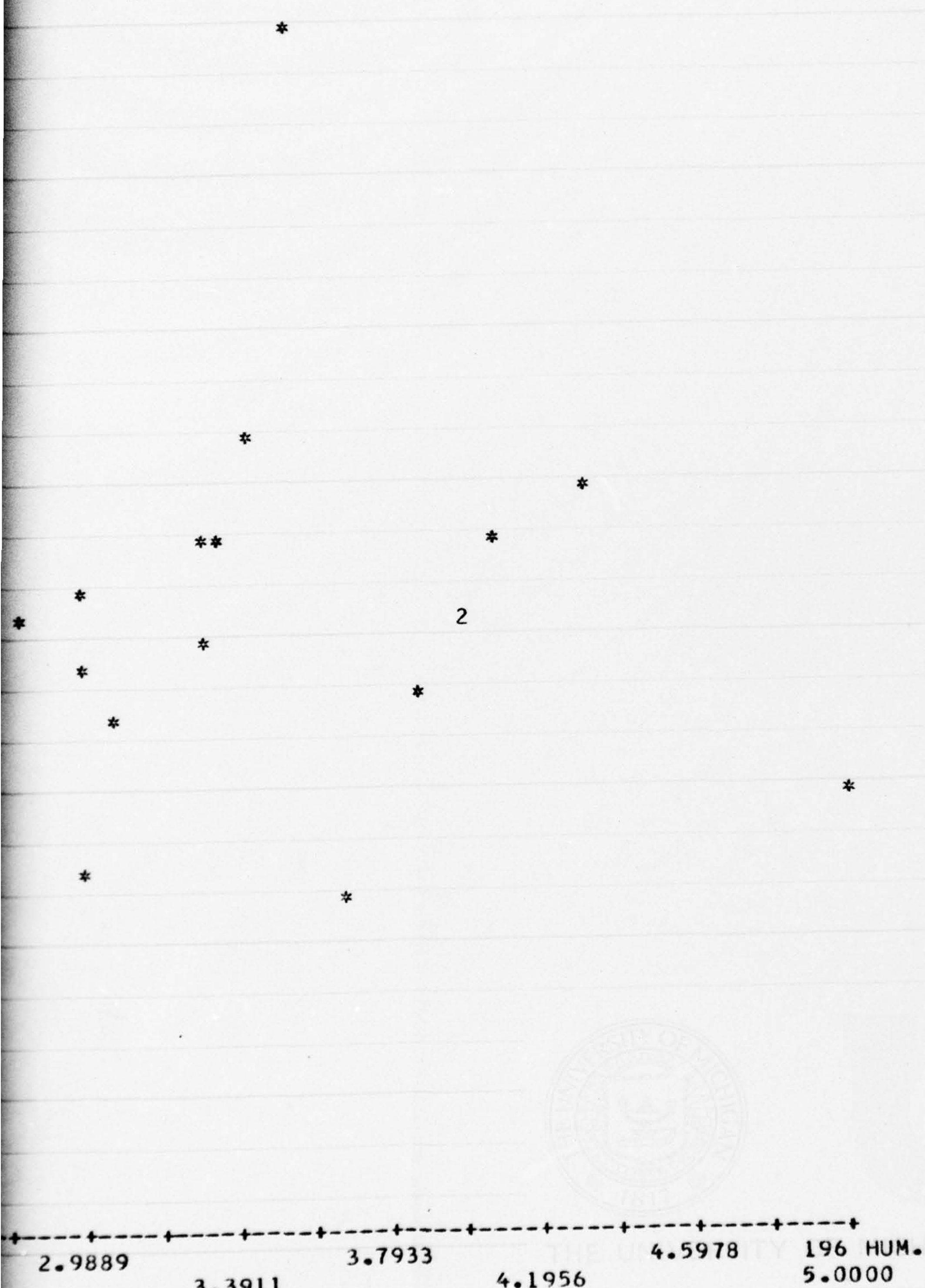


B-102



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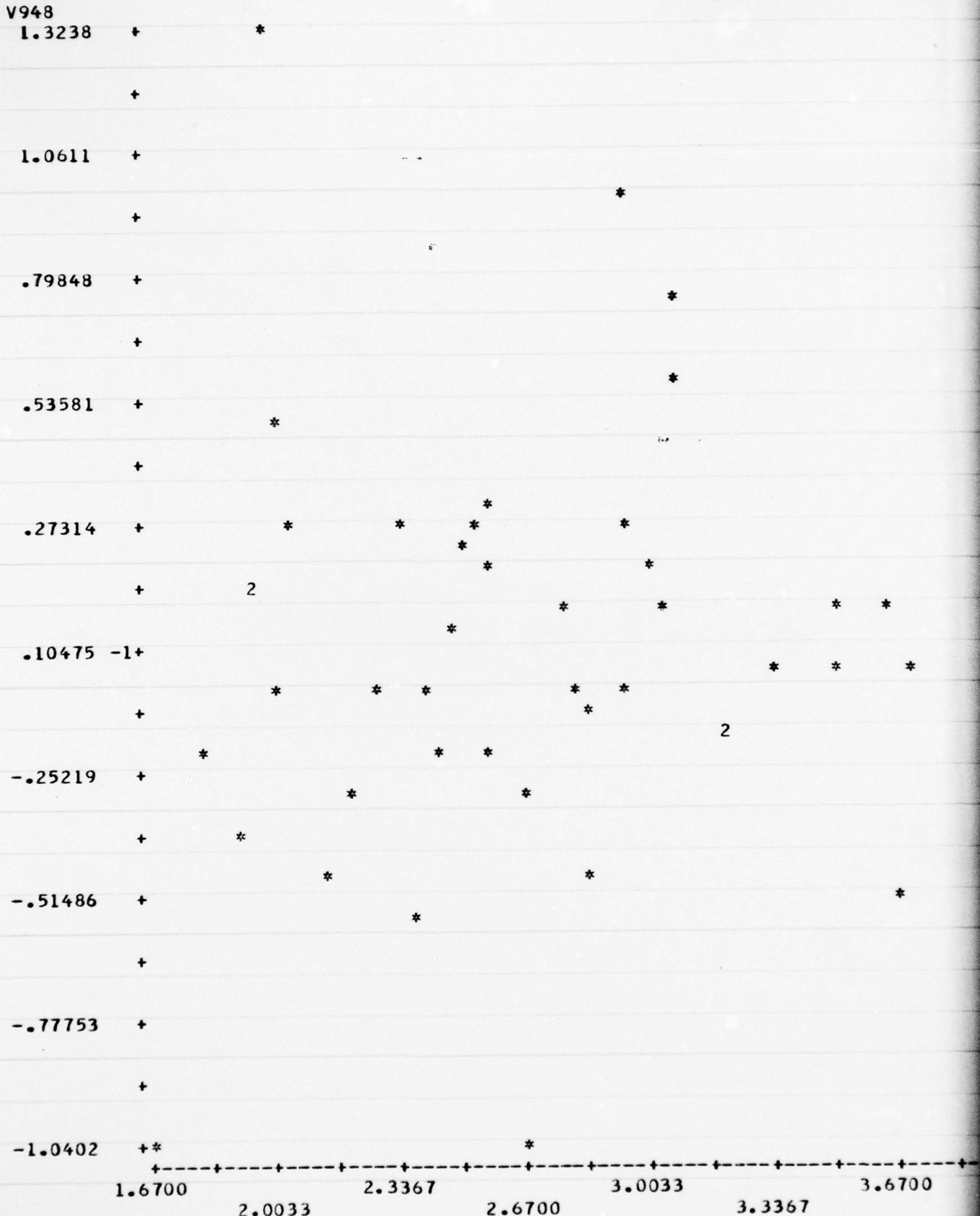

B-103

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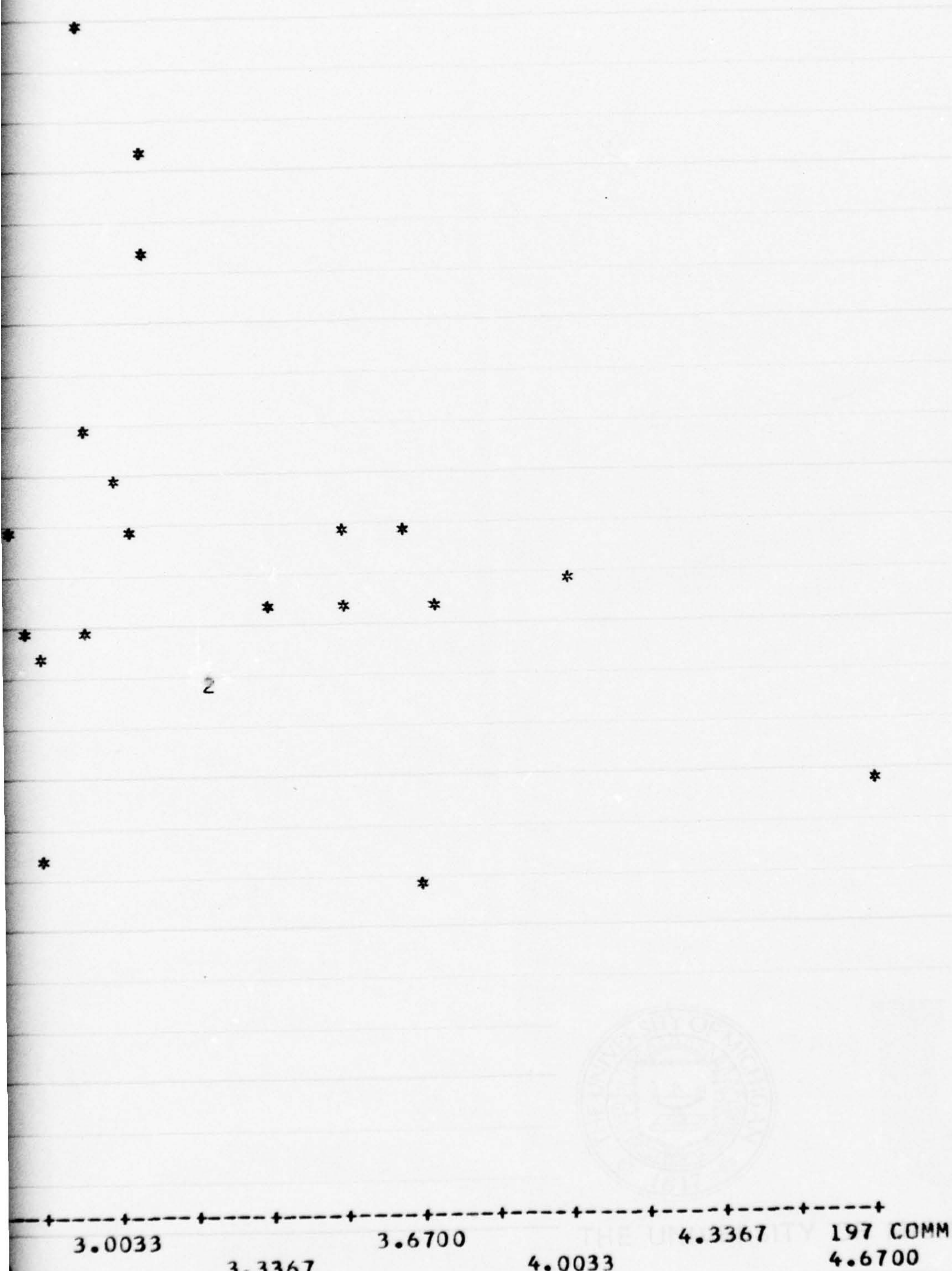

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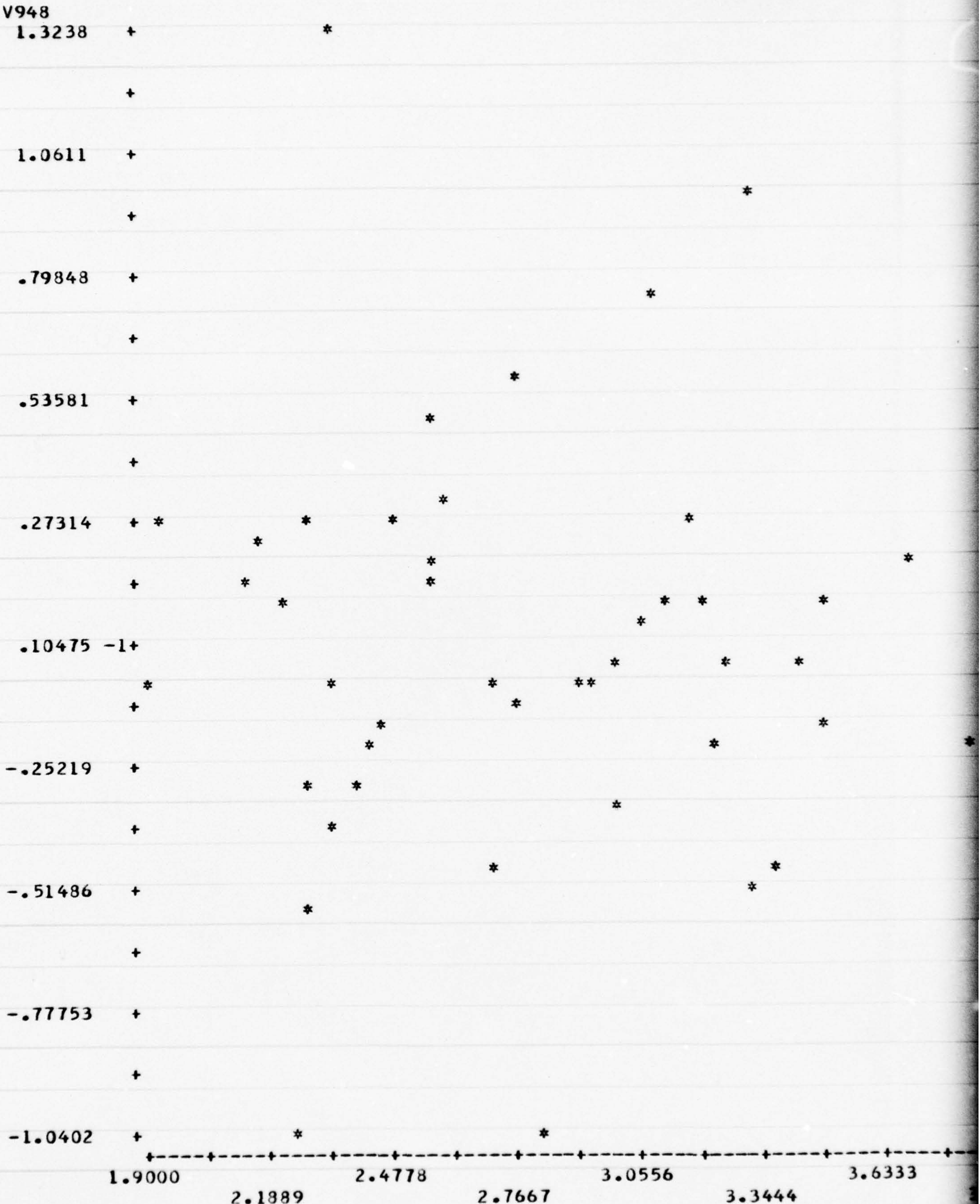

B-104

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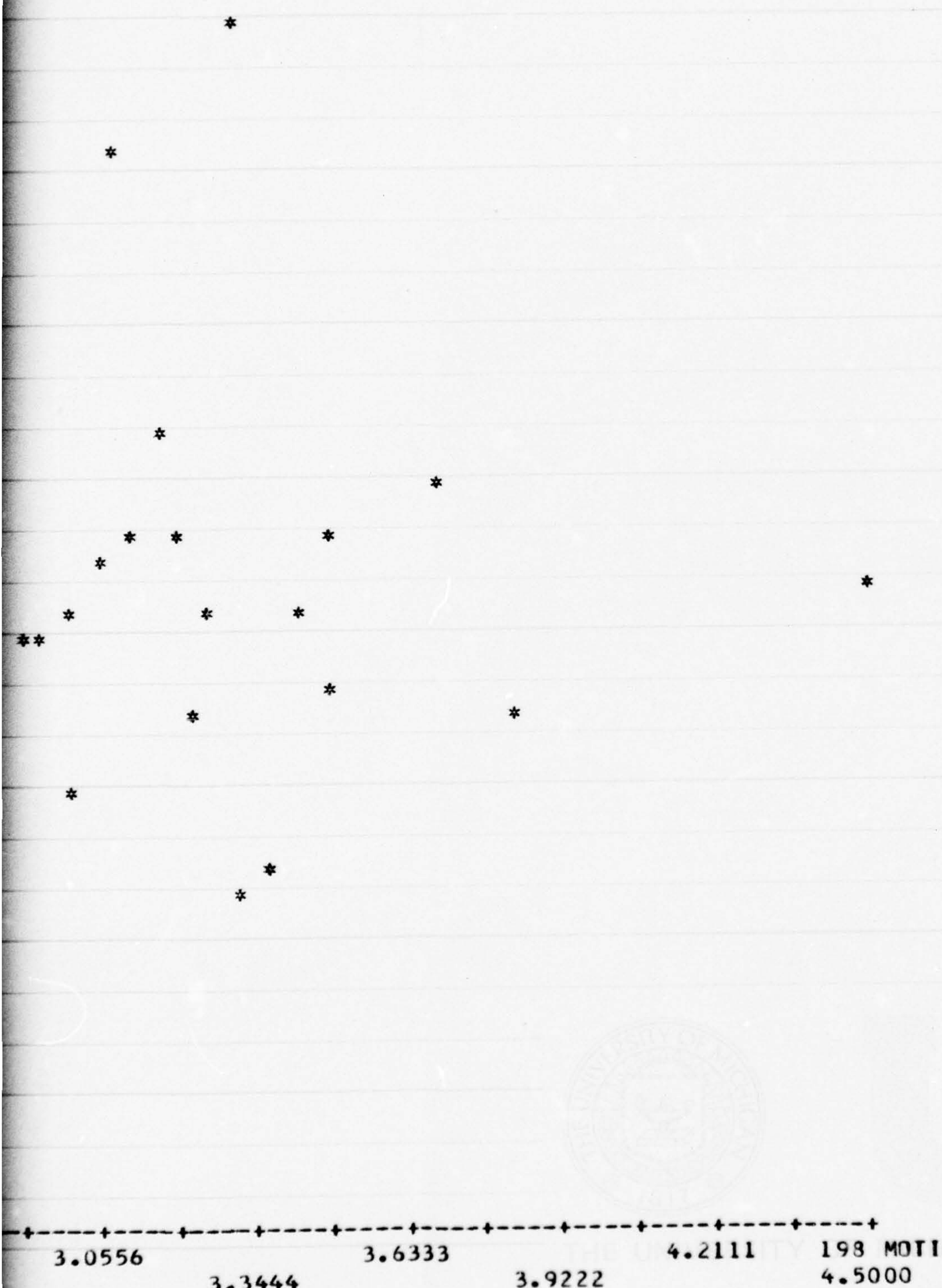

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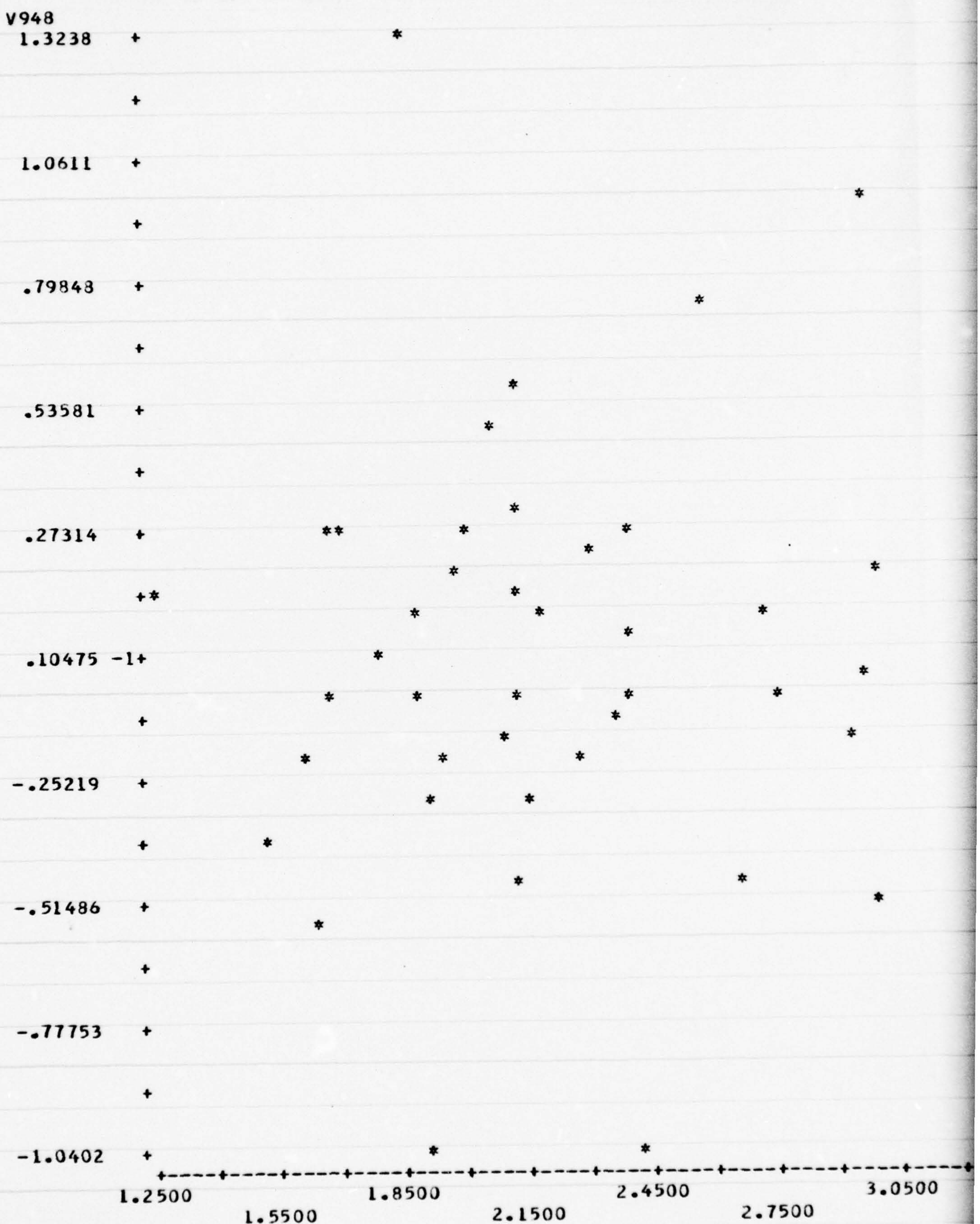

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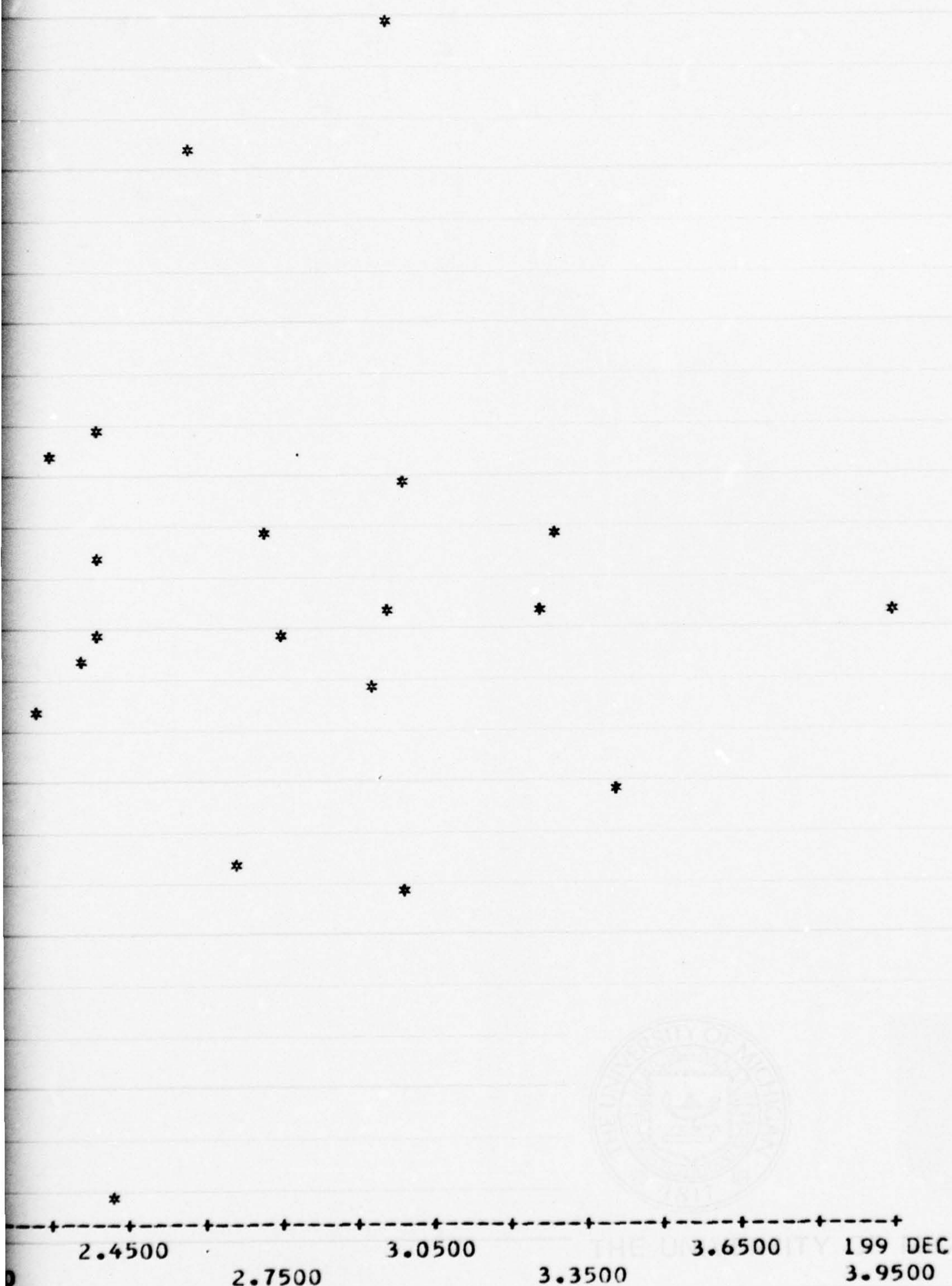

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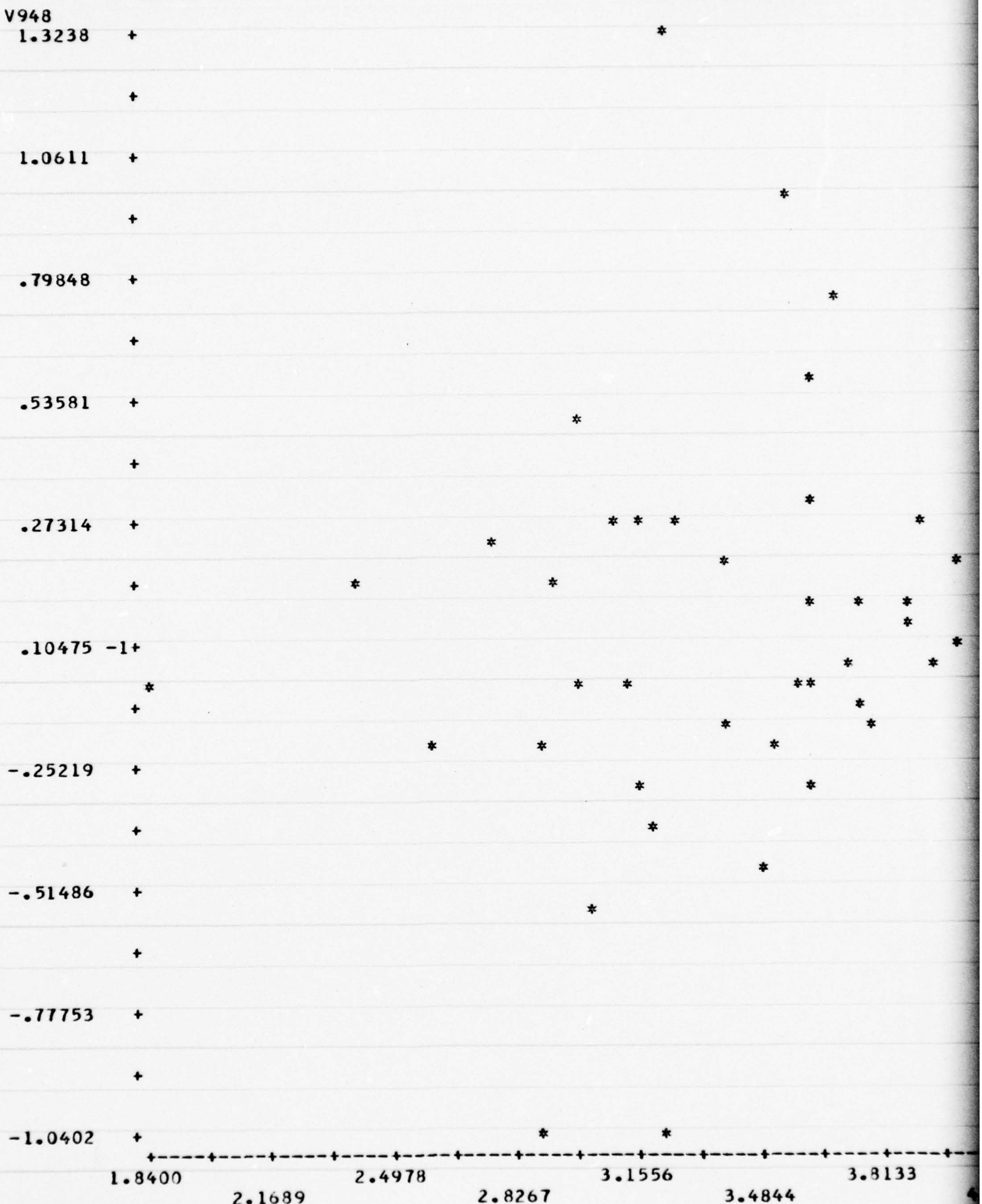

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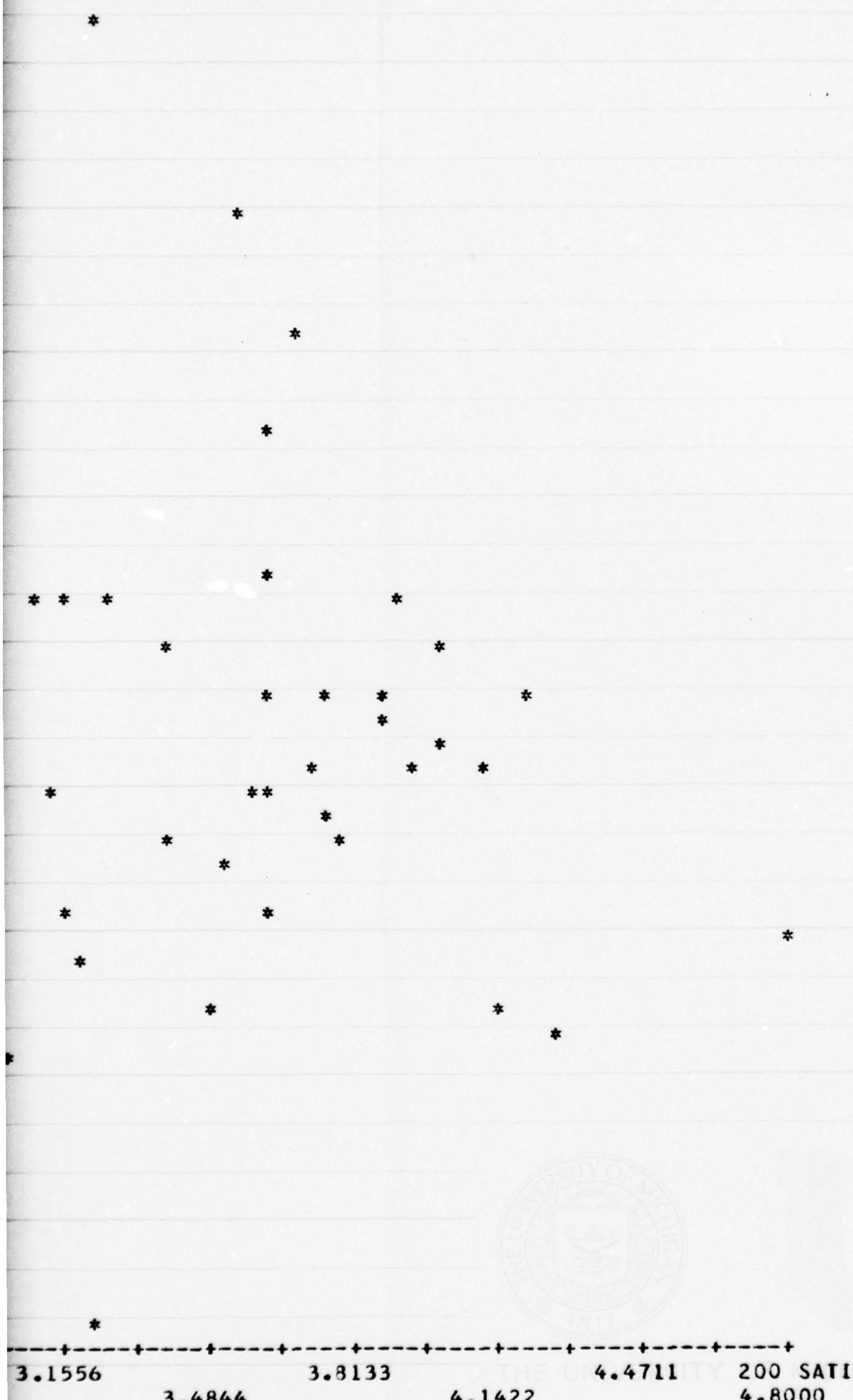

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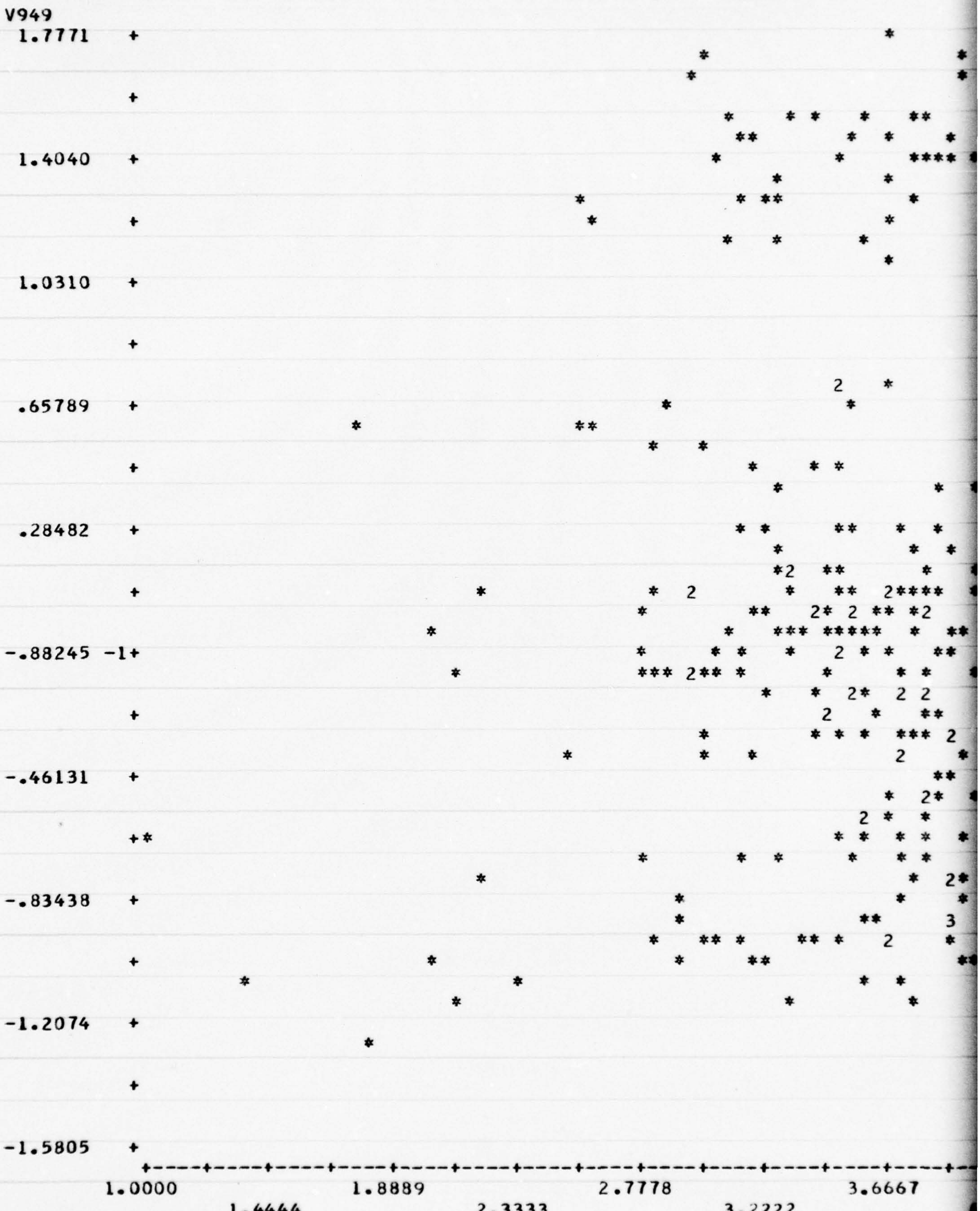

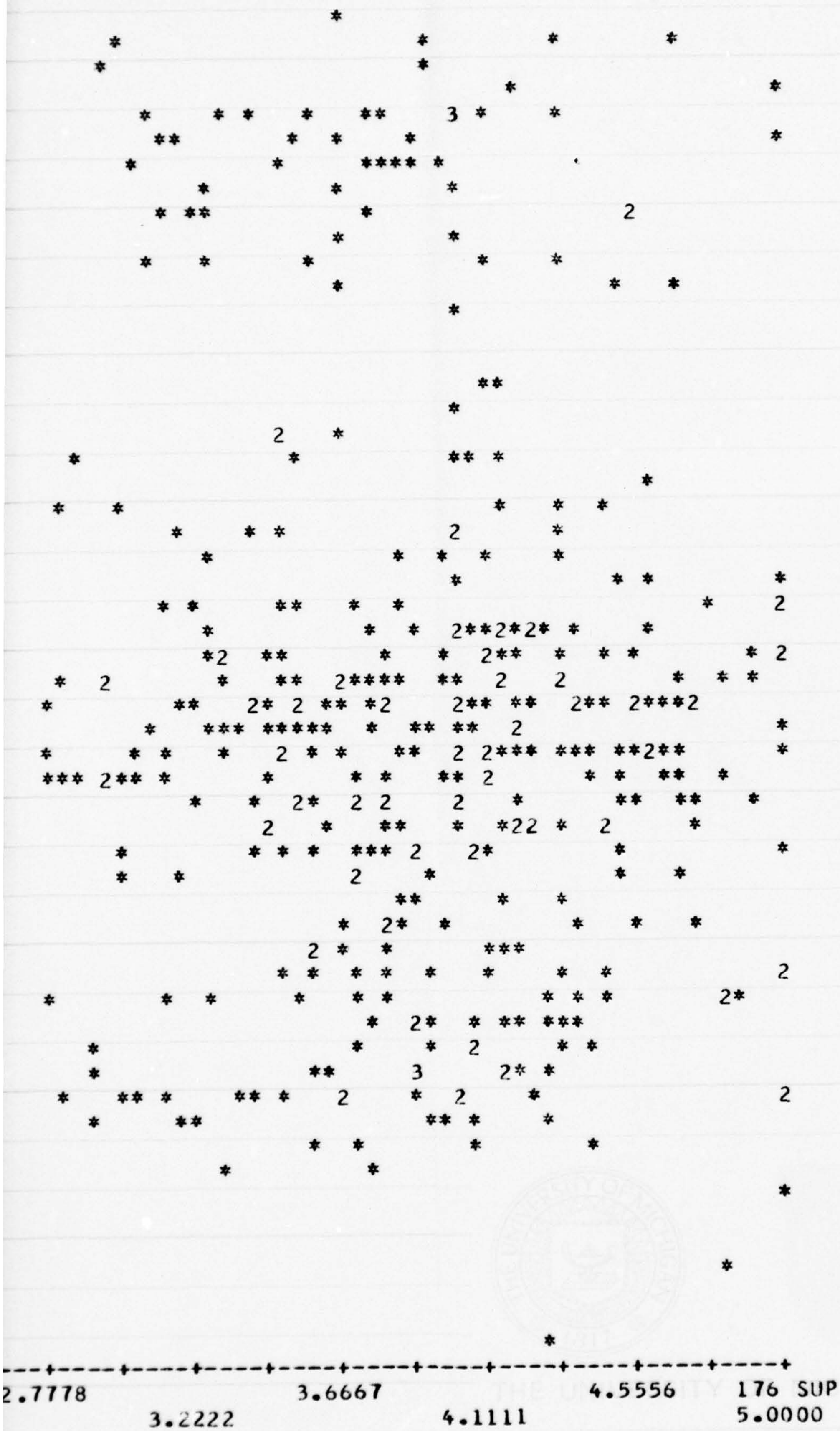
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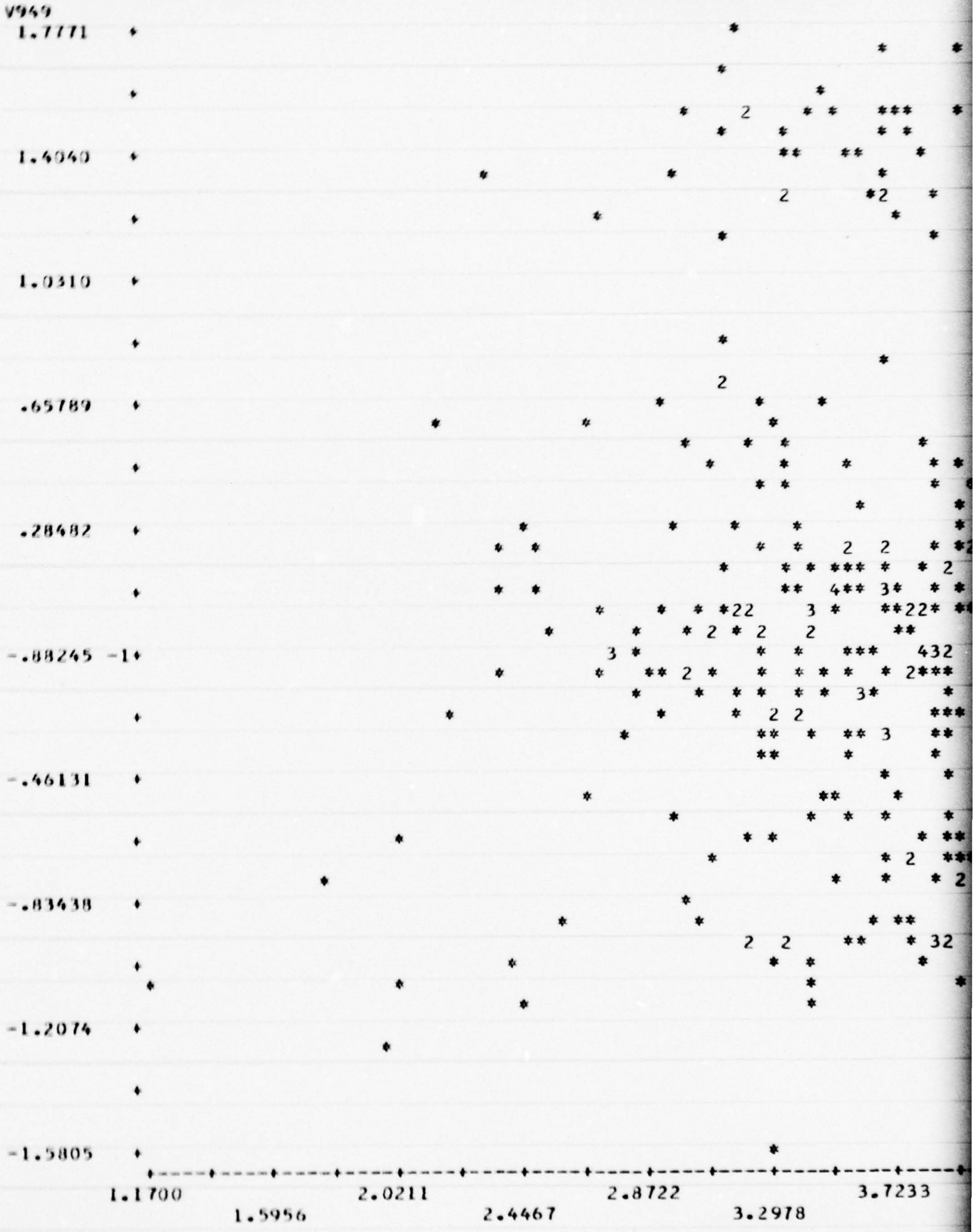
4.5556
176 SUP
5.0000

SCATTER PLOT



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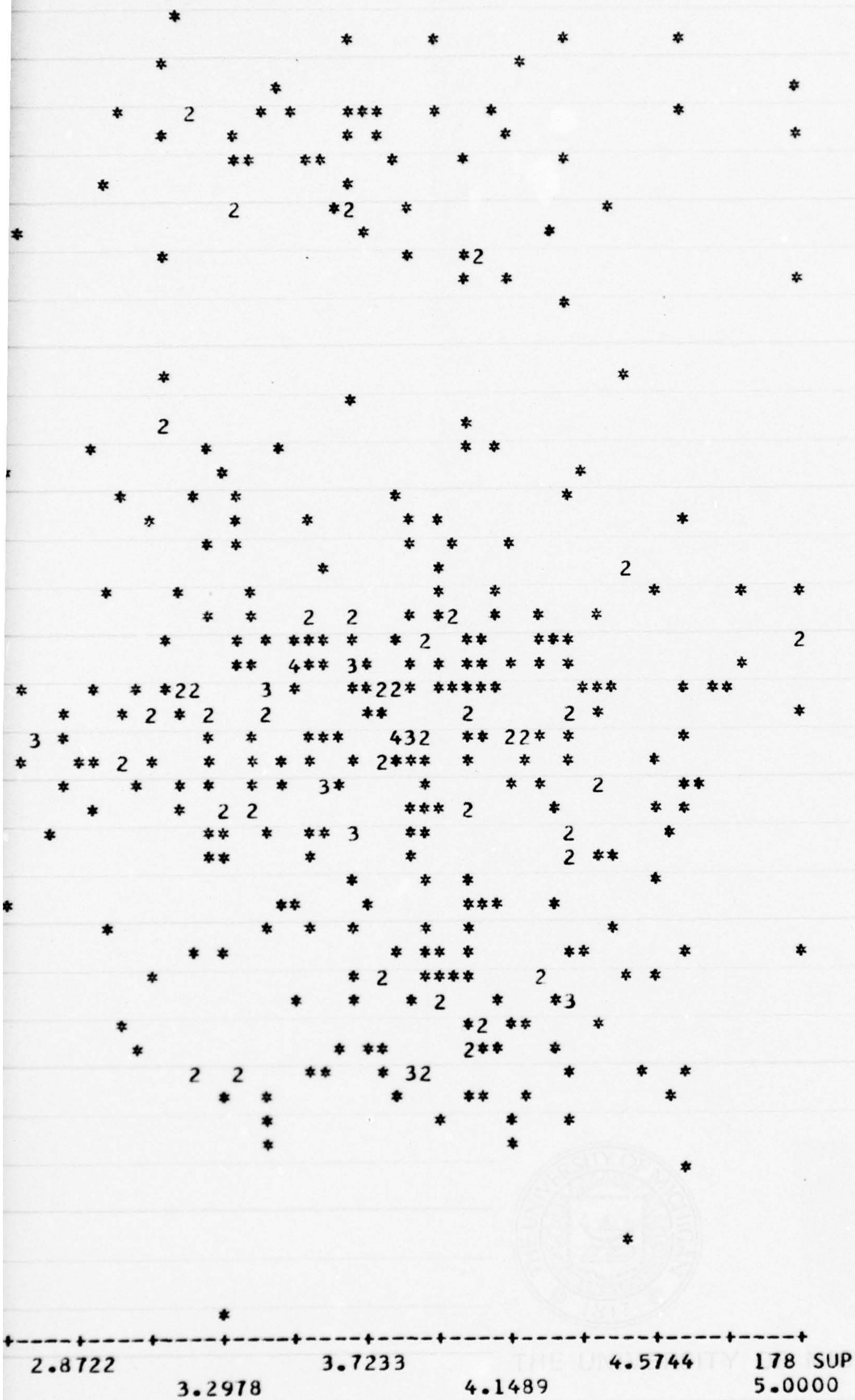

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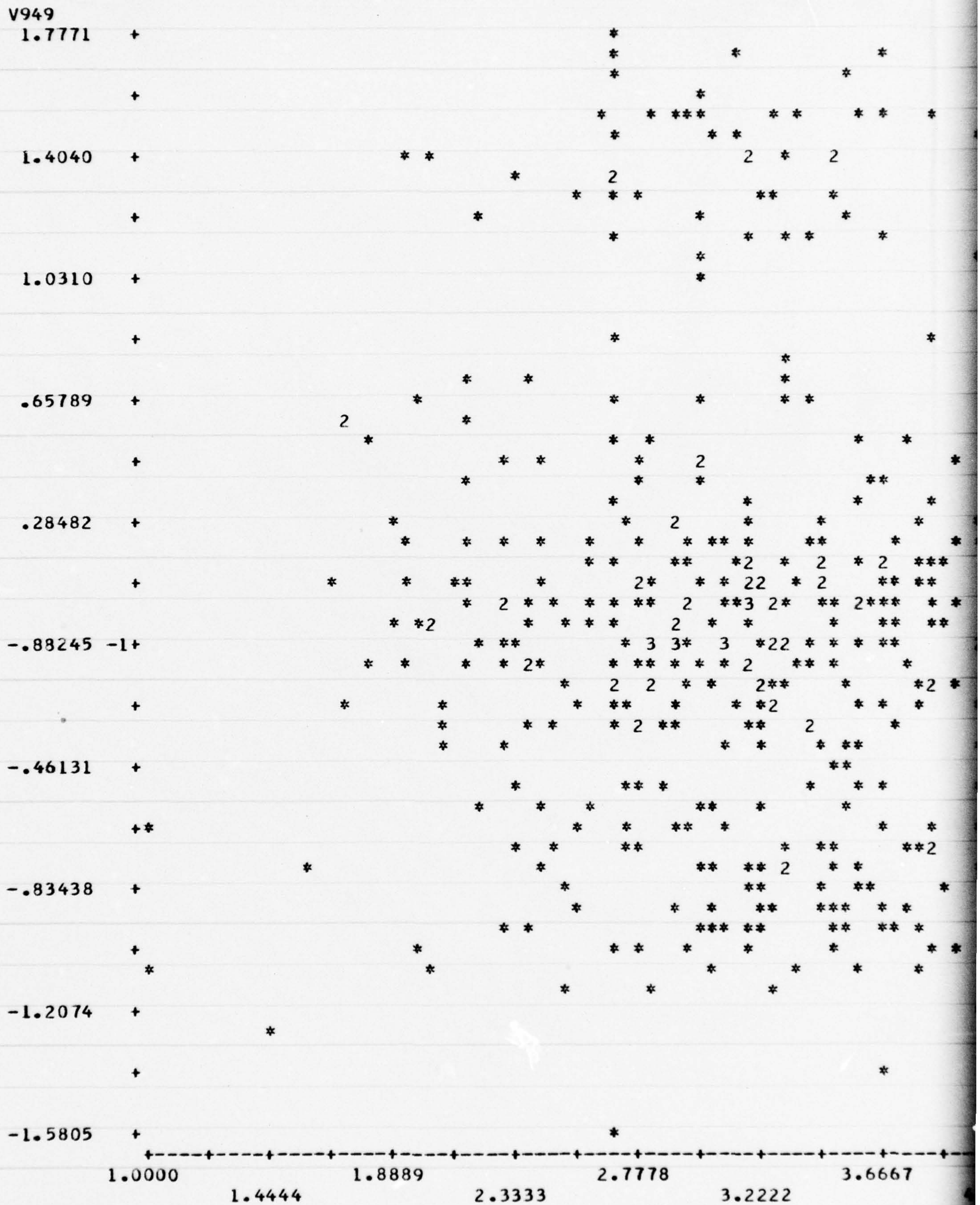

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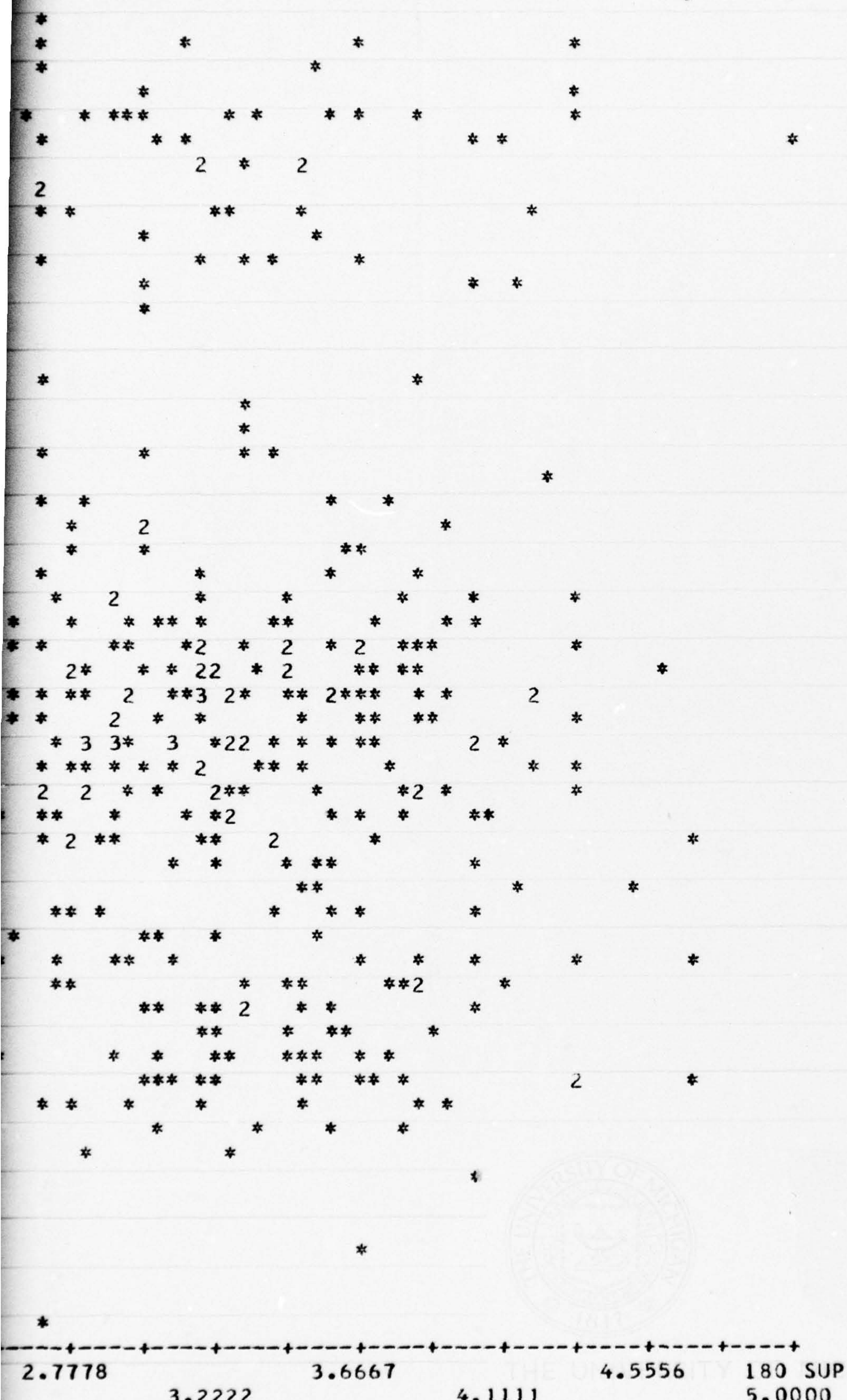

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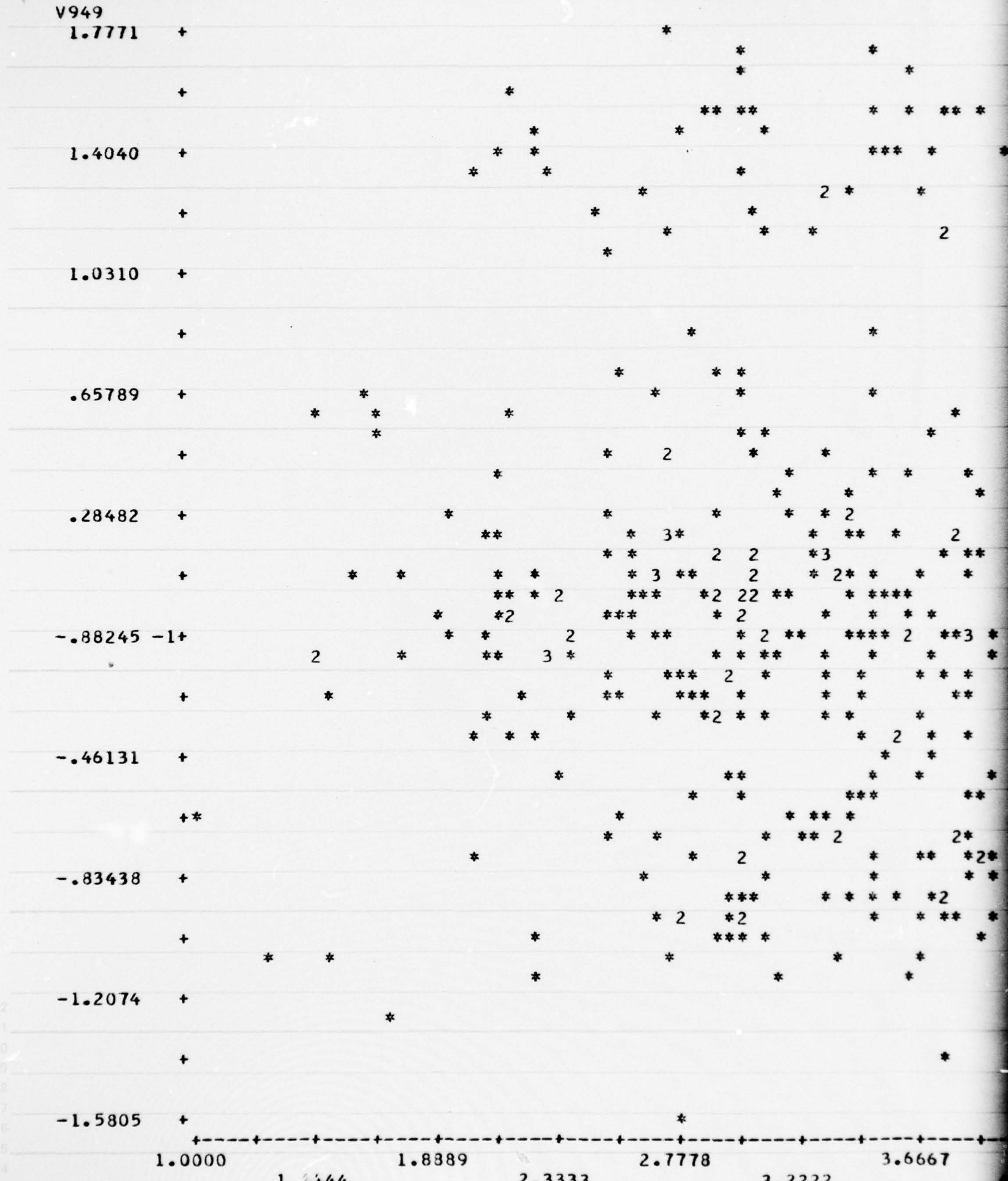

B-110

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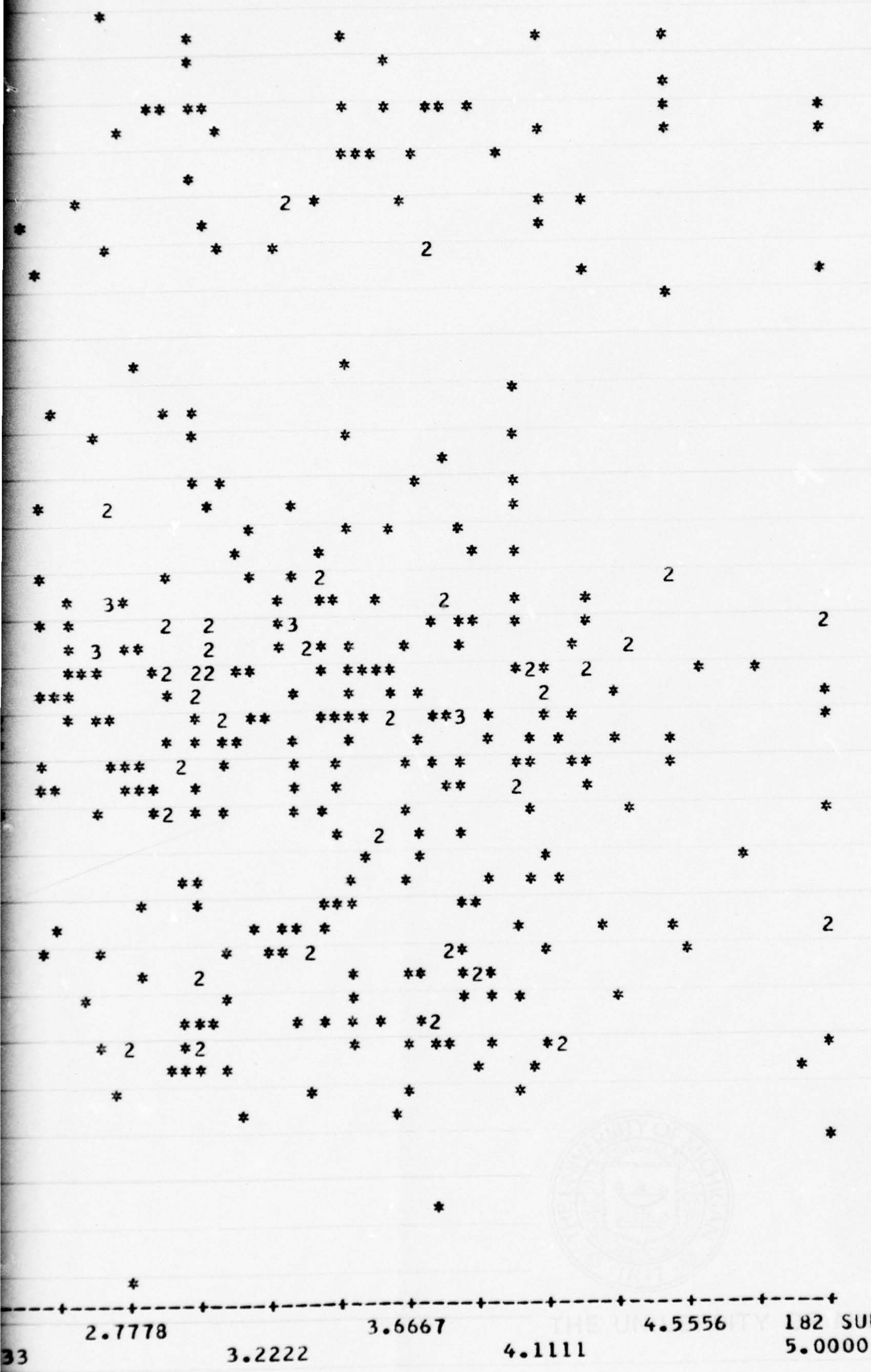

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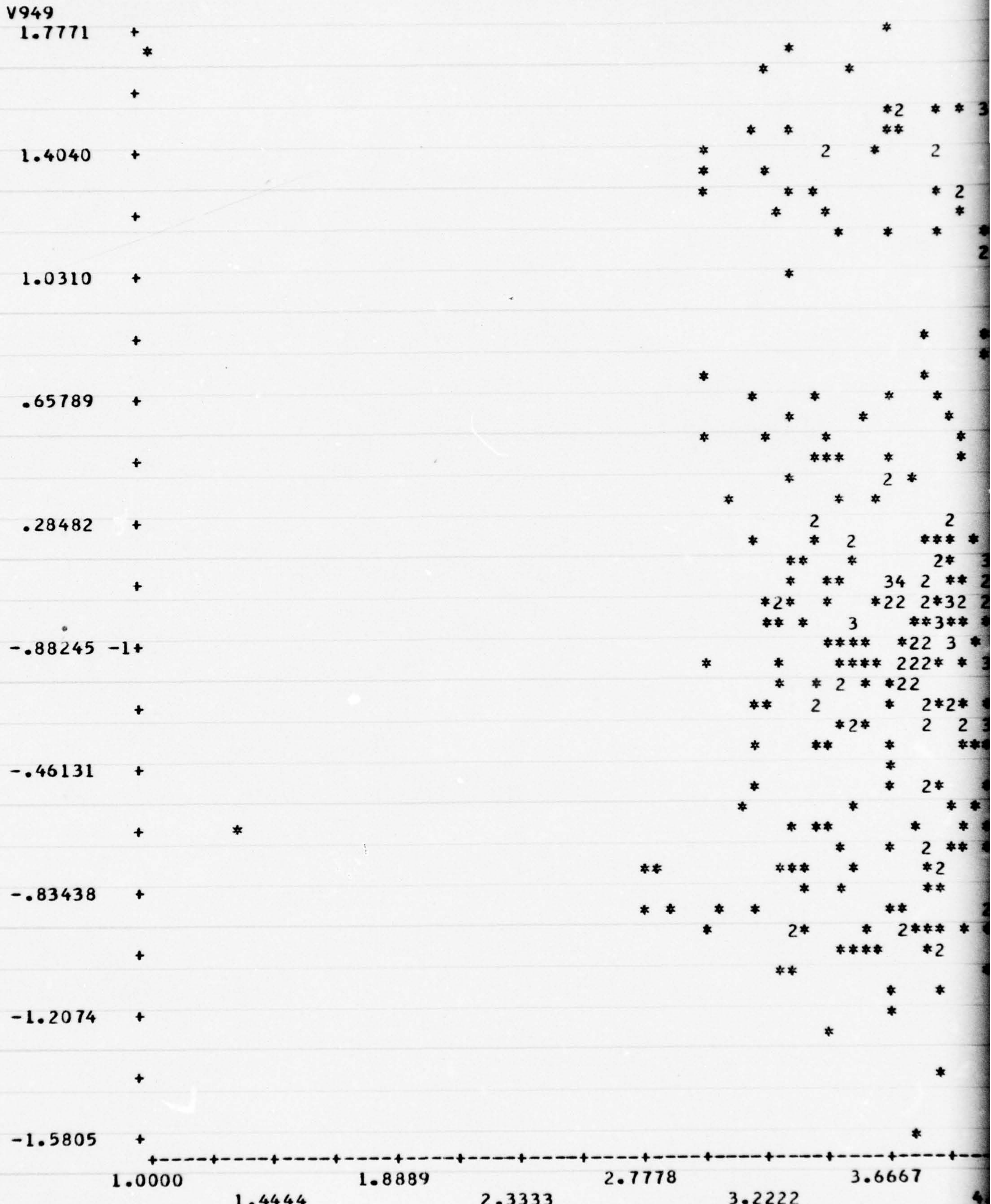

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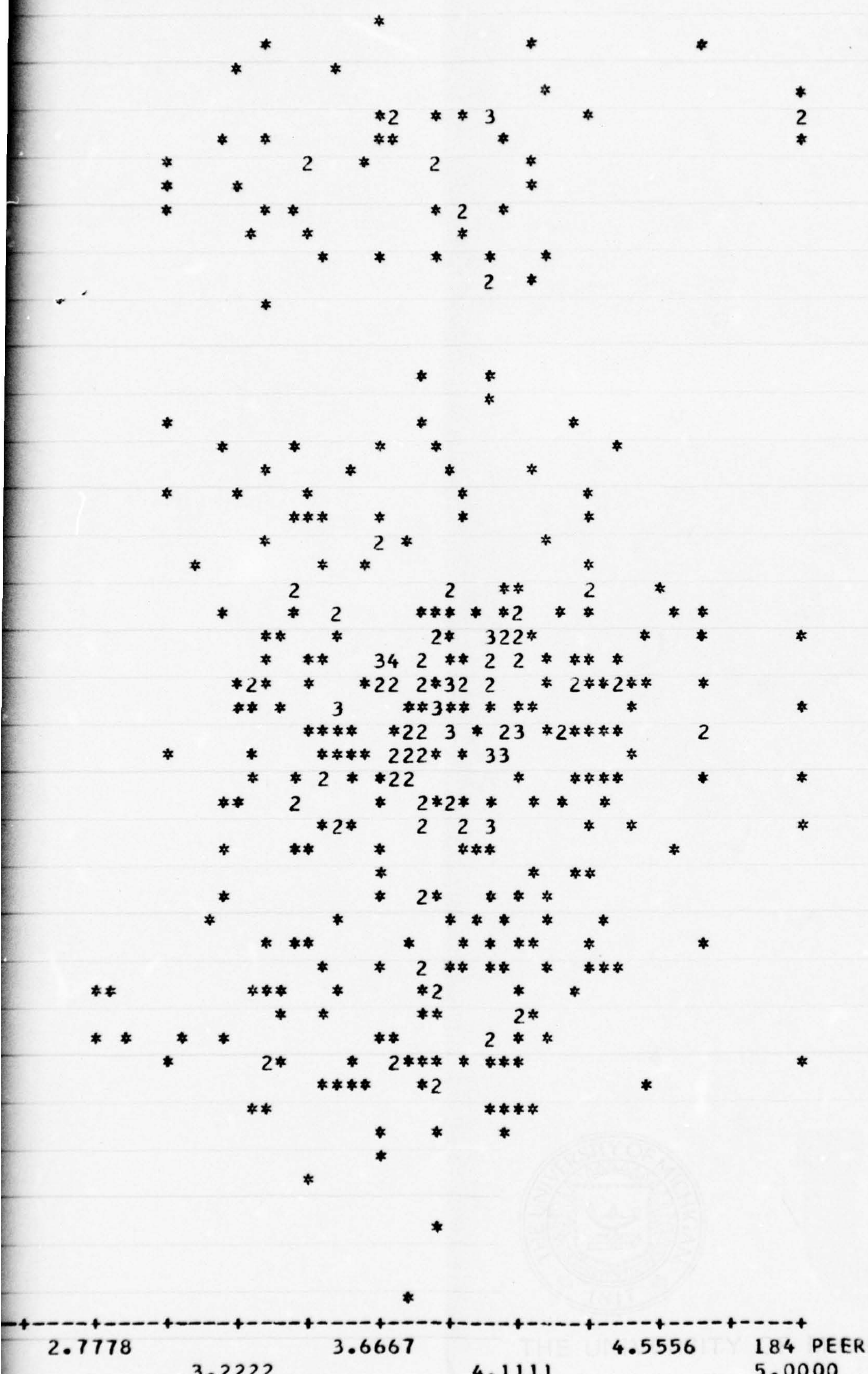

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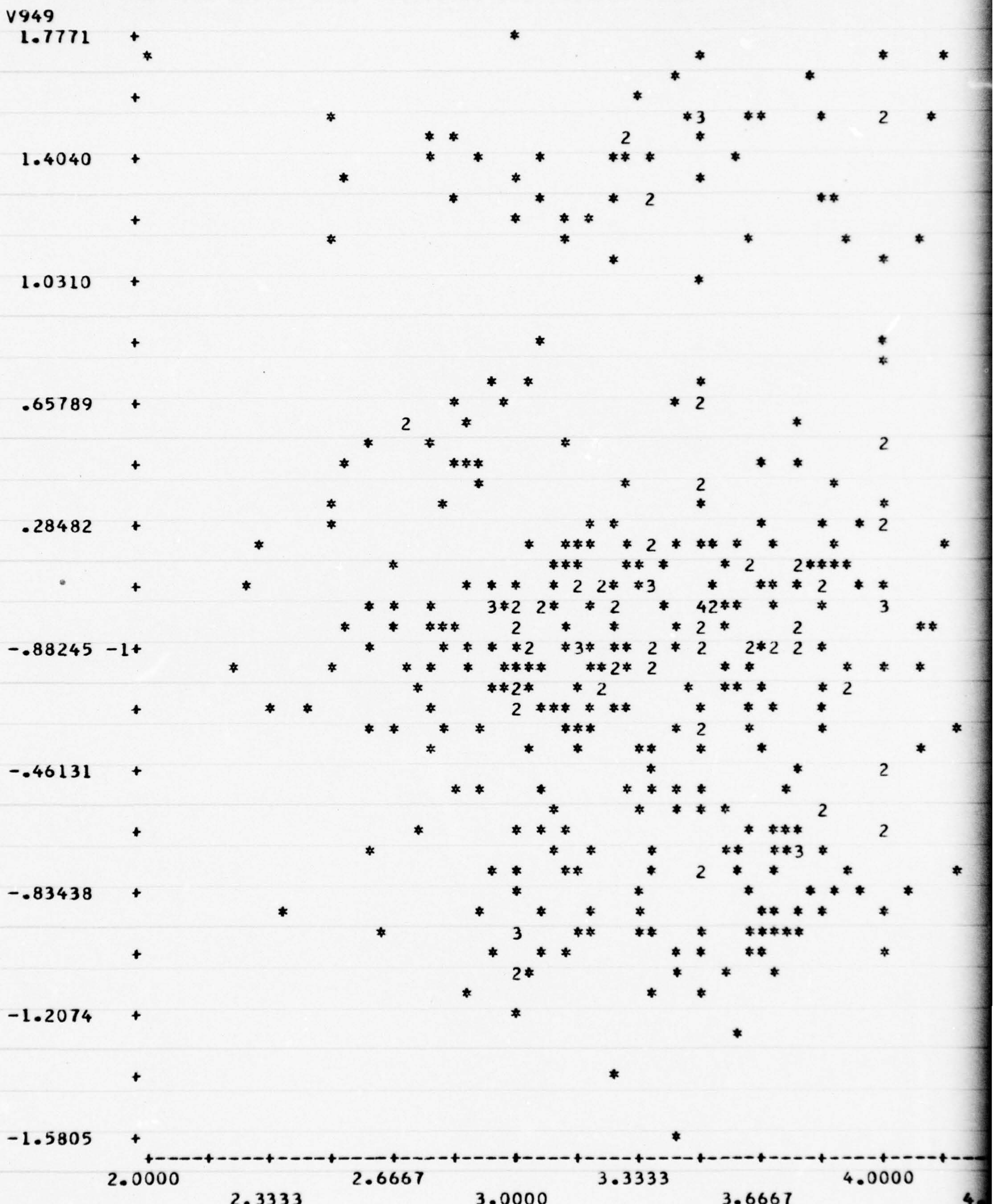

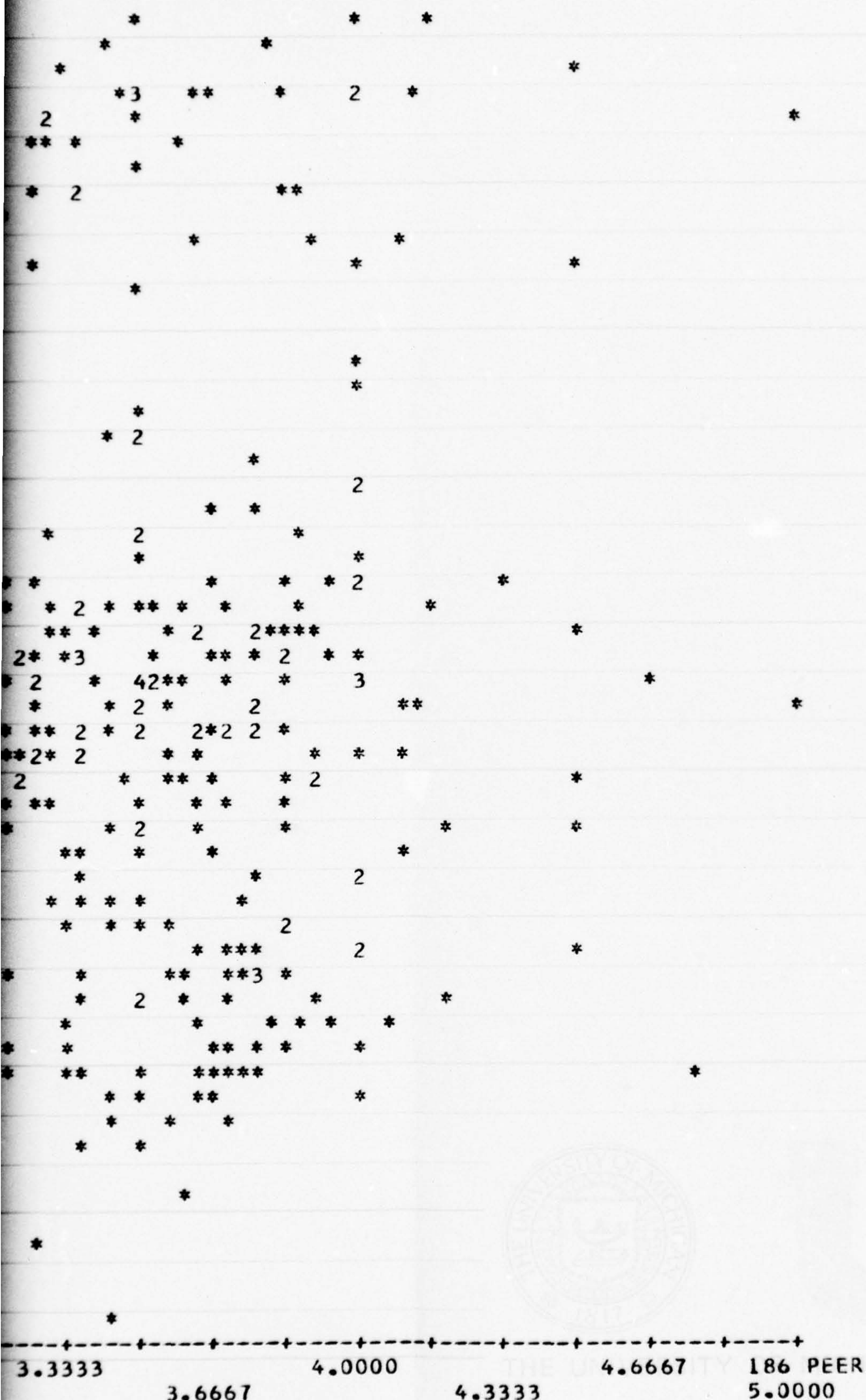
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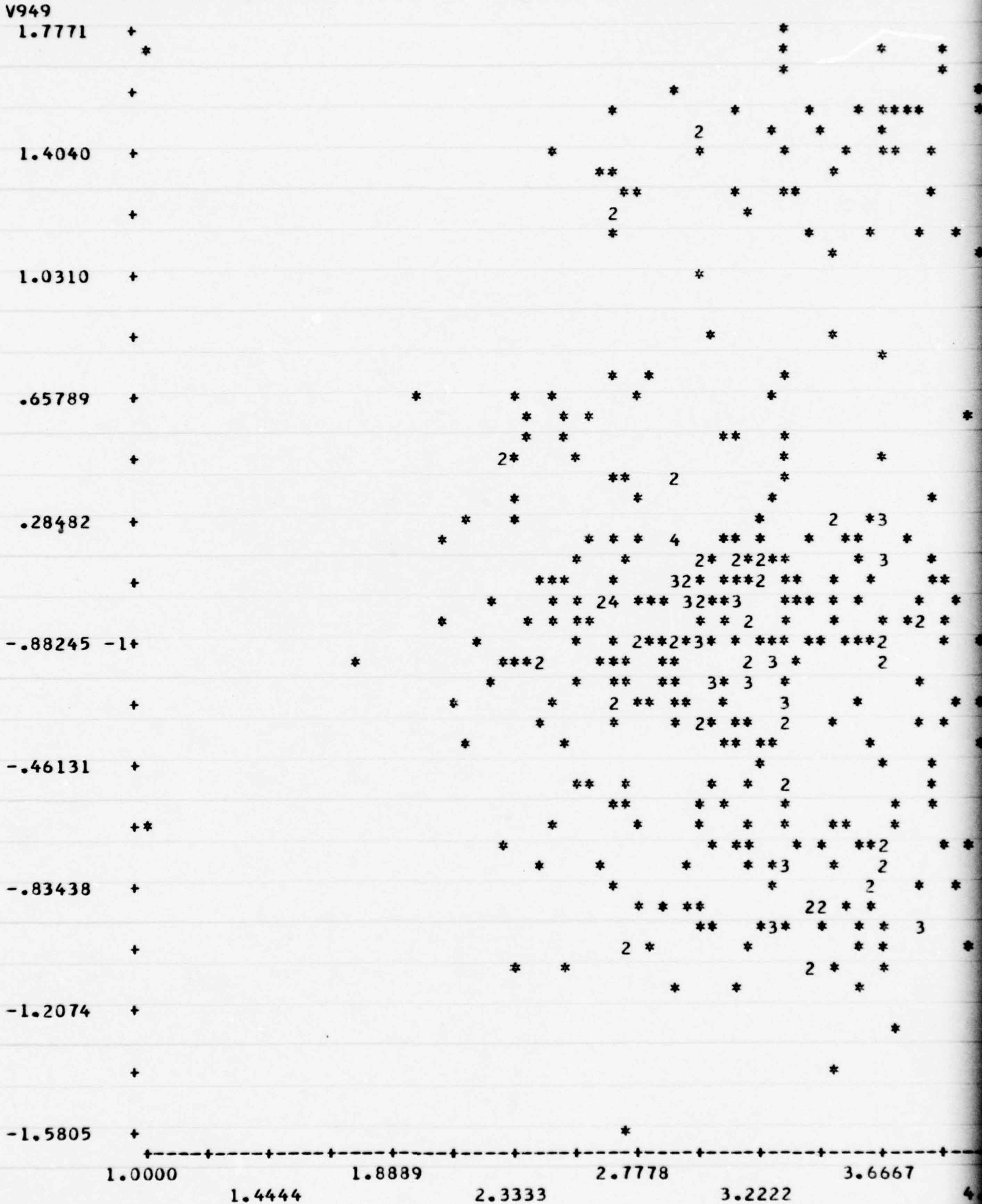

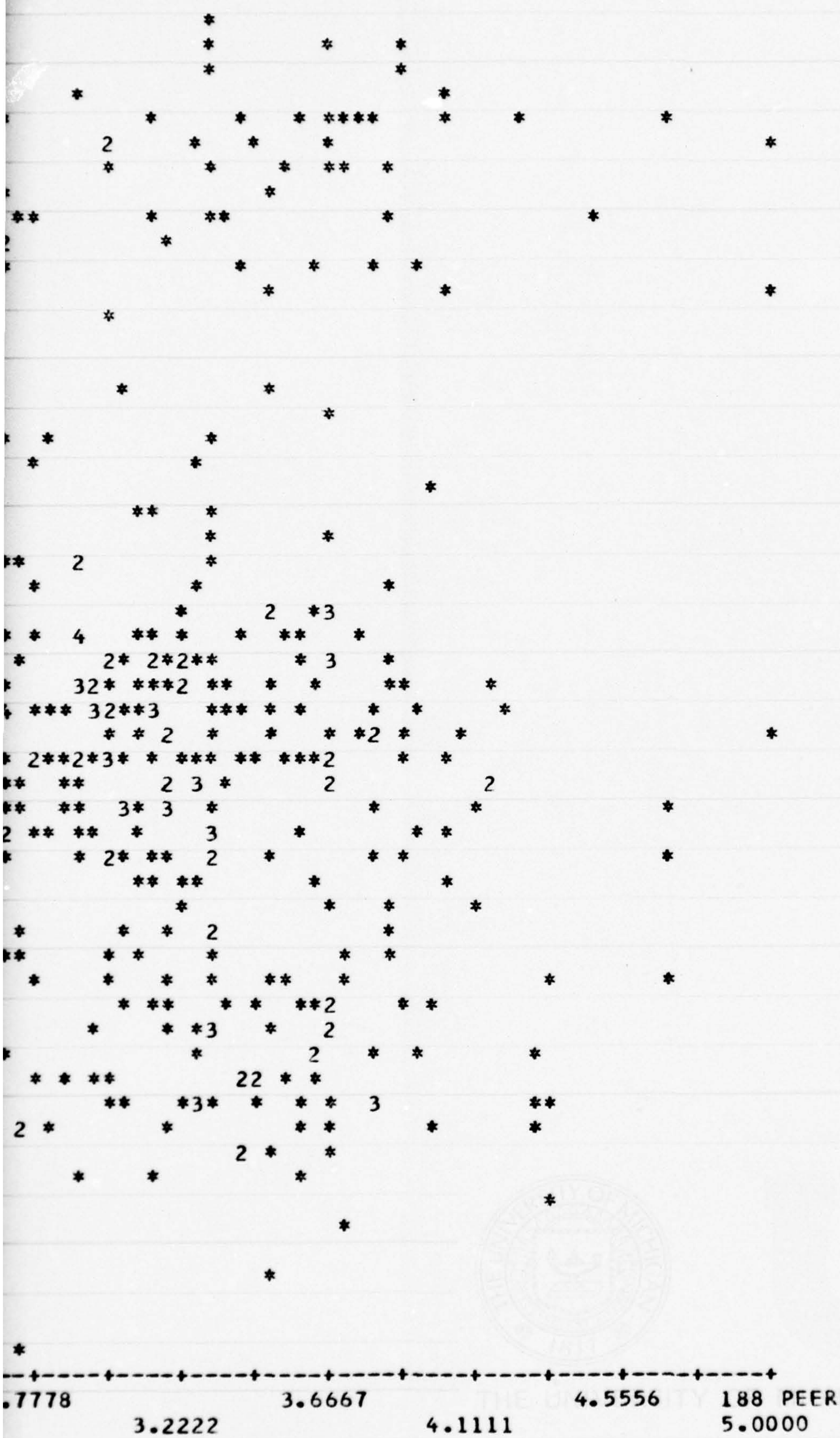
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188 PEER

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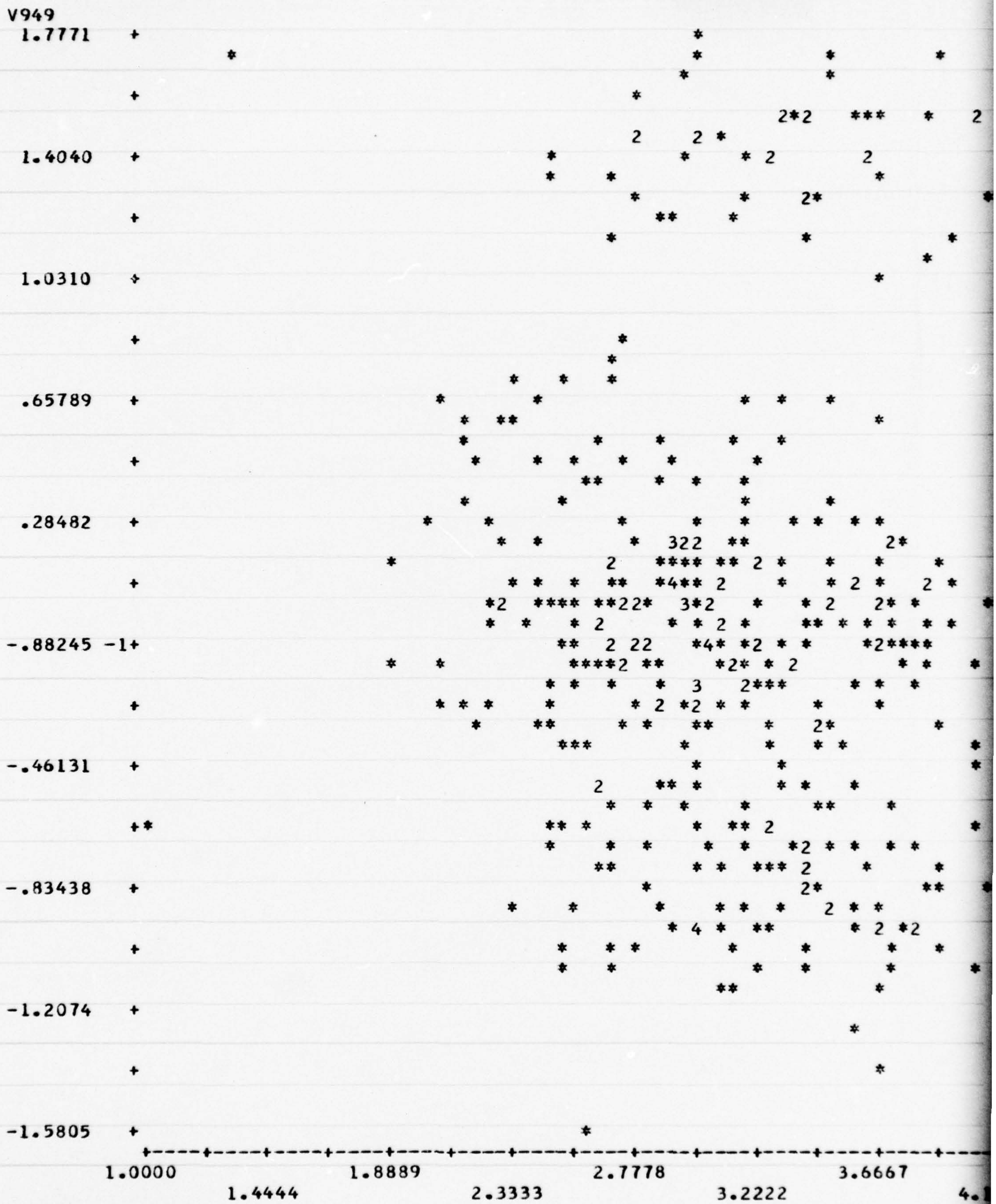

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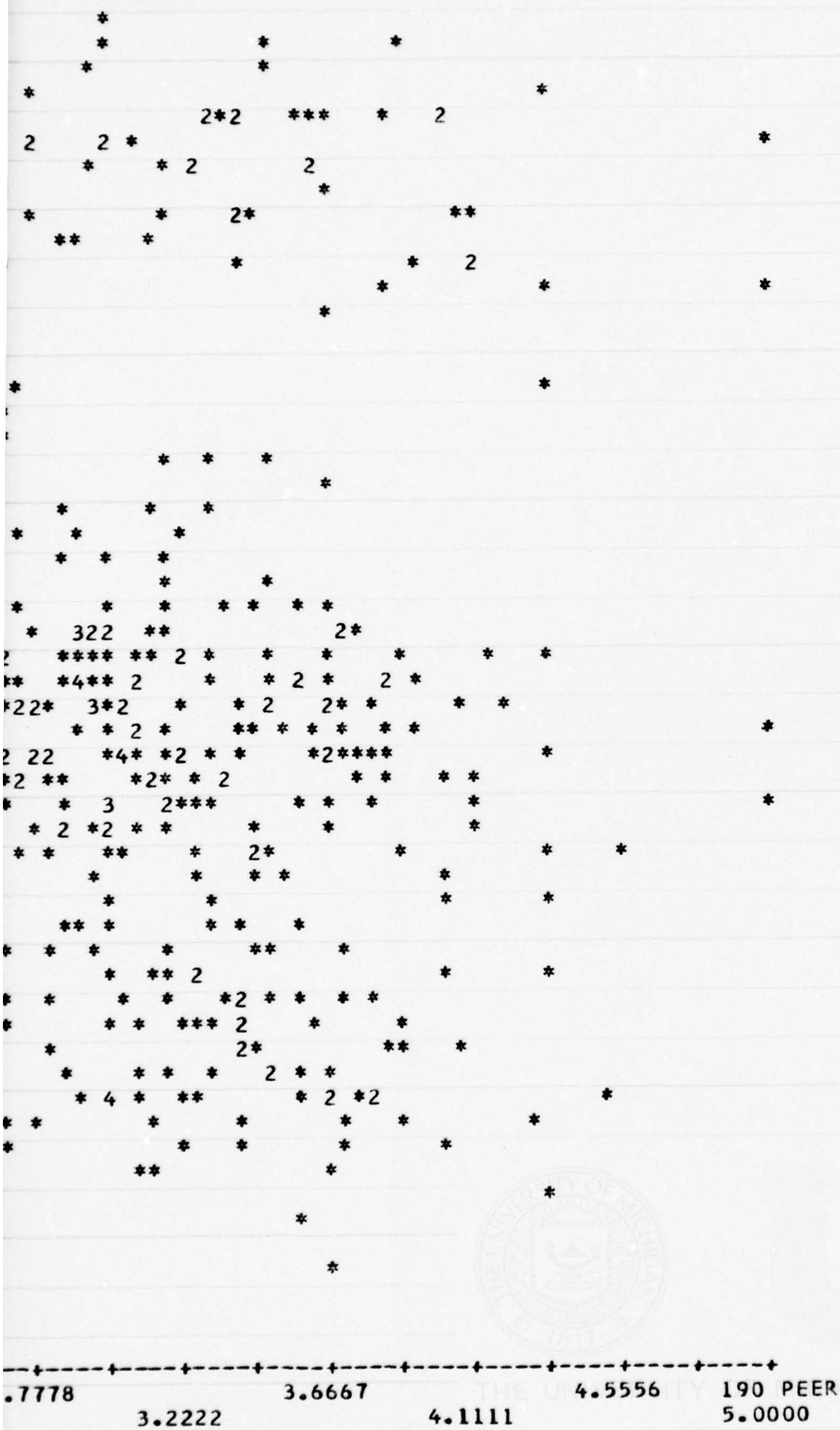

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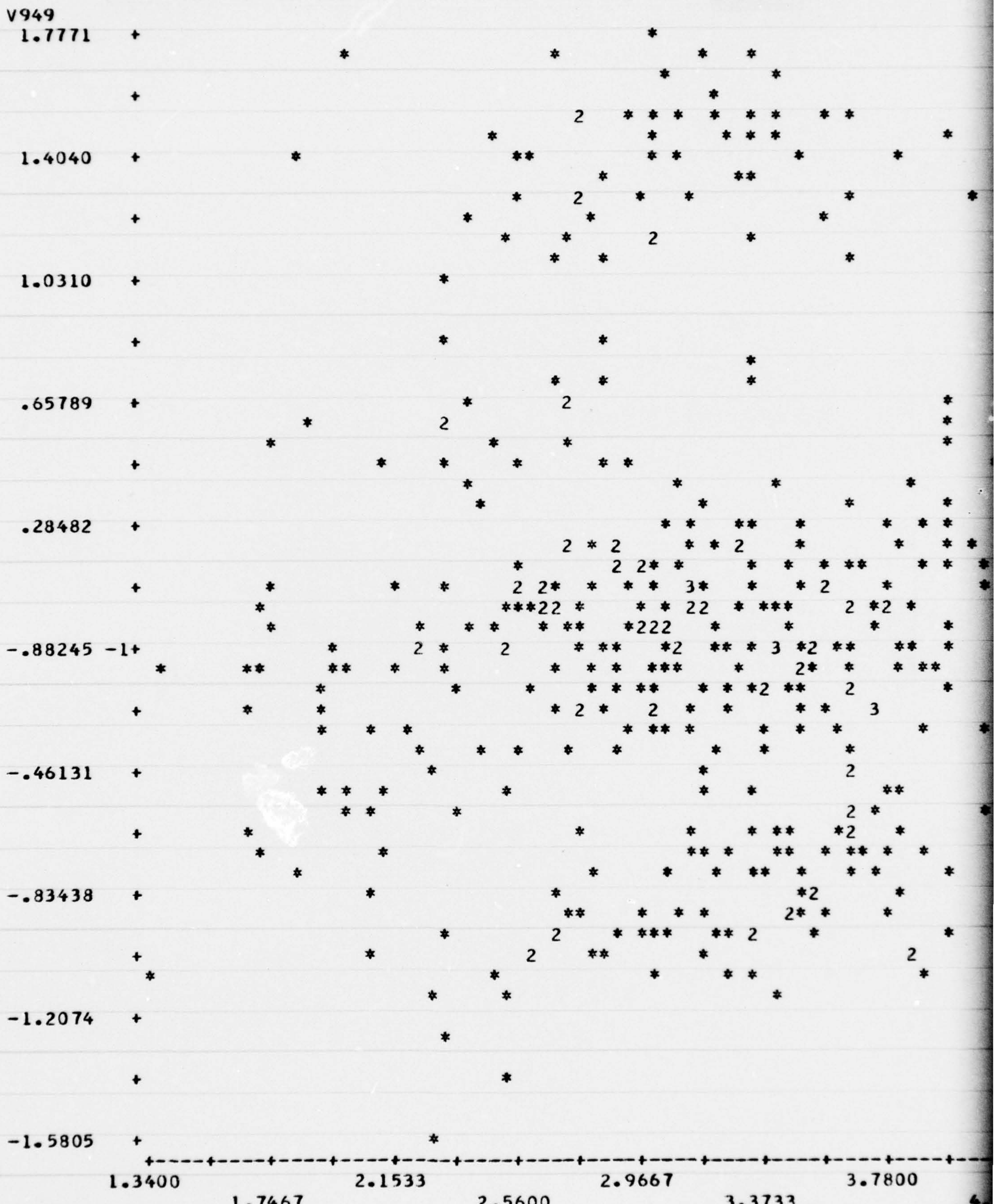

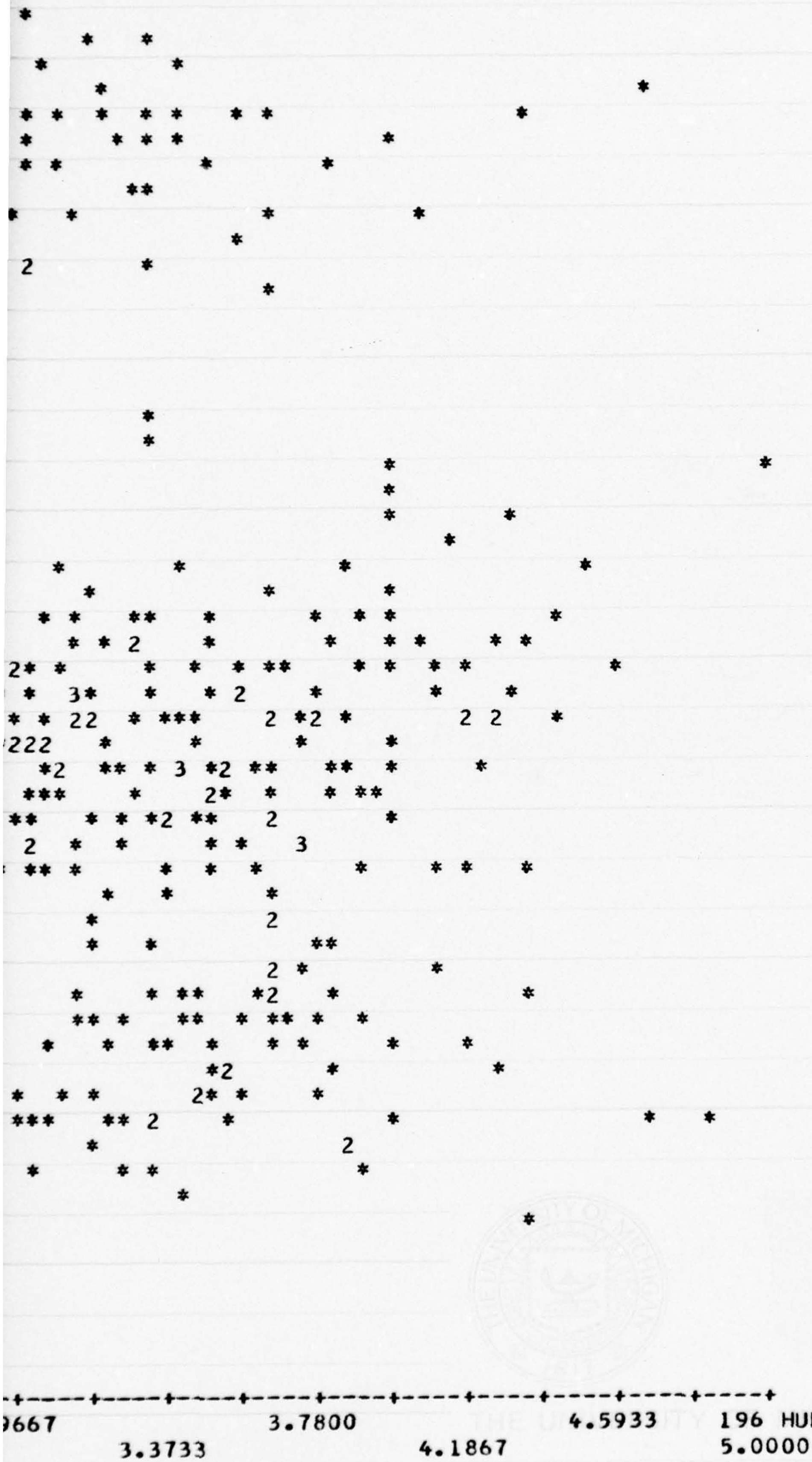
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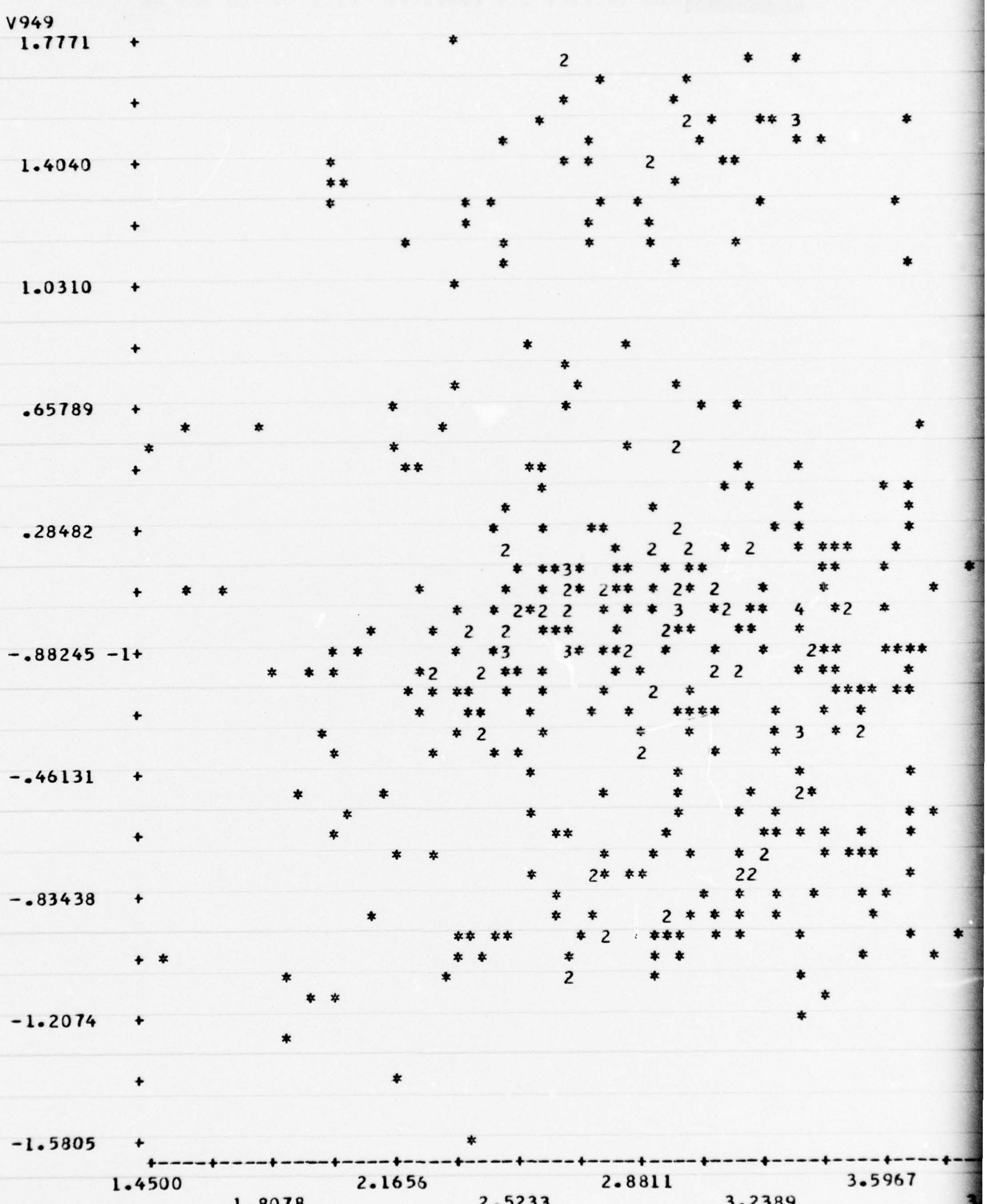
196 HUM.
5.0000

SCATTER PLOT



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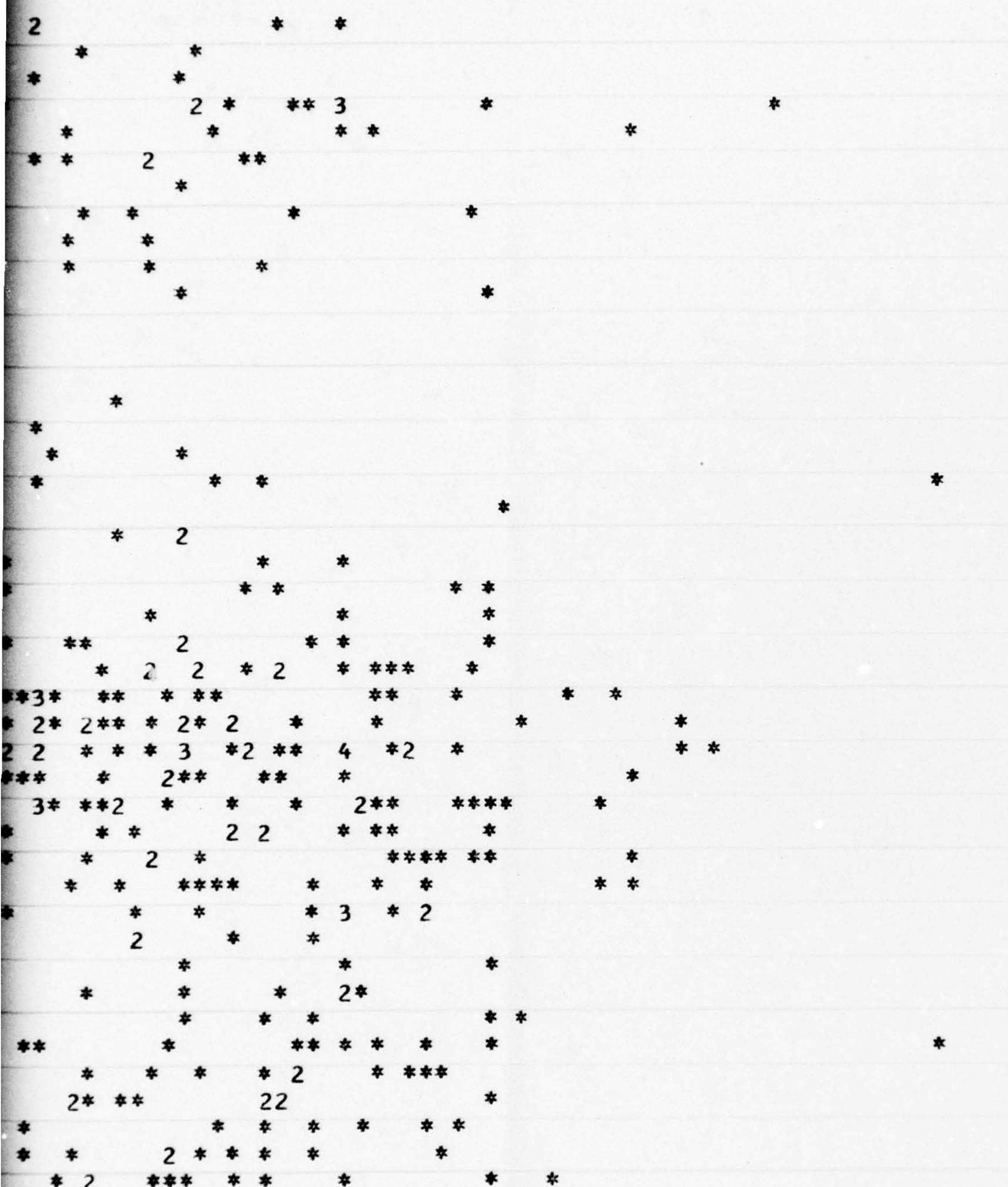

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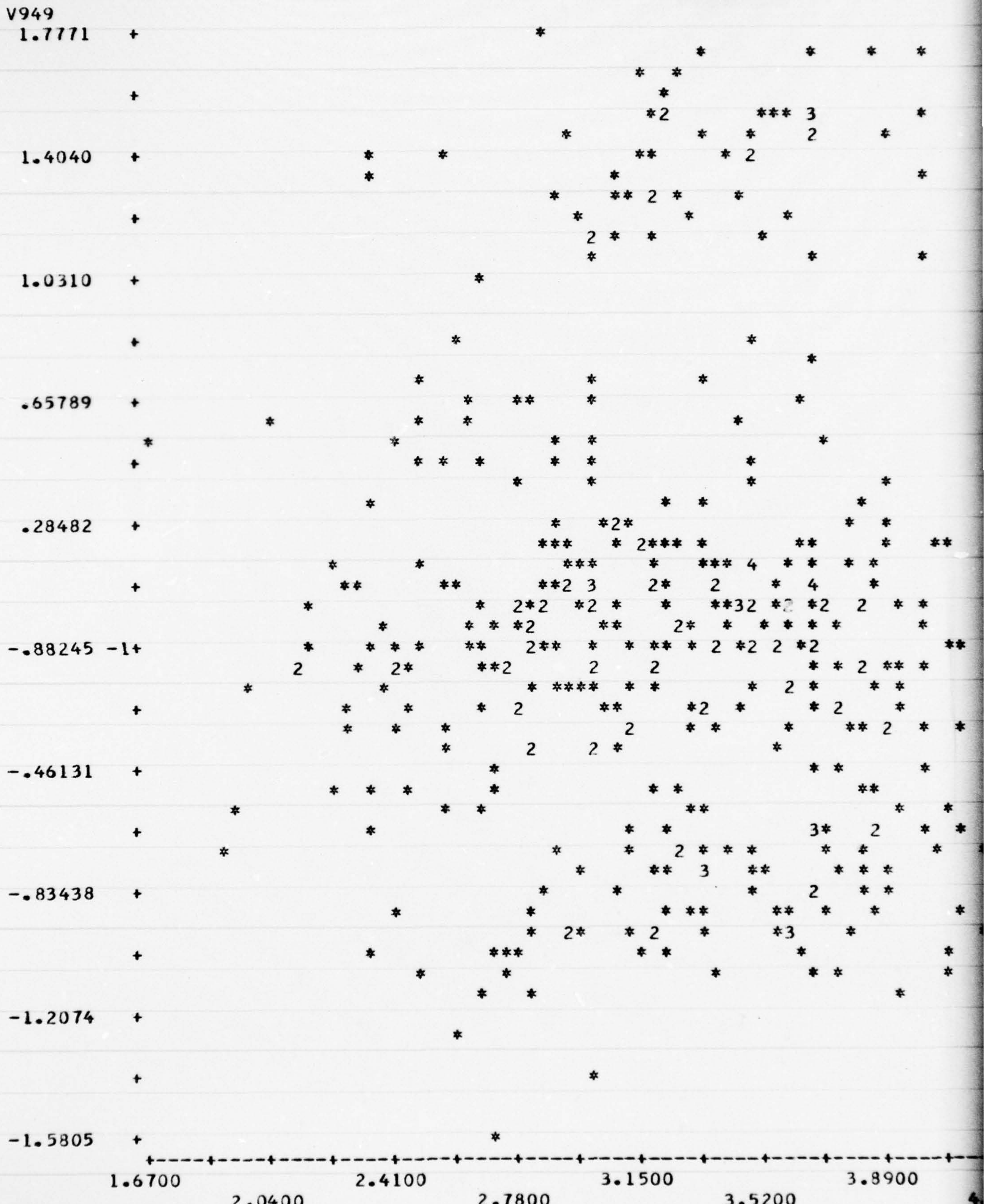

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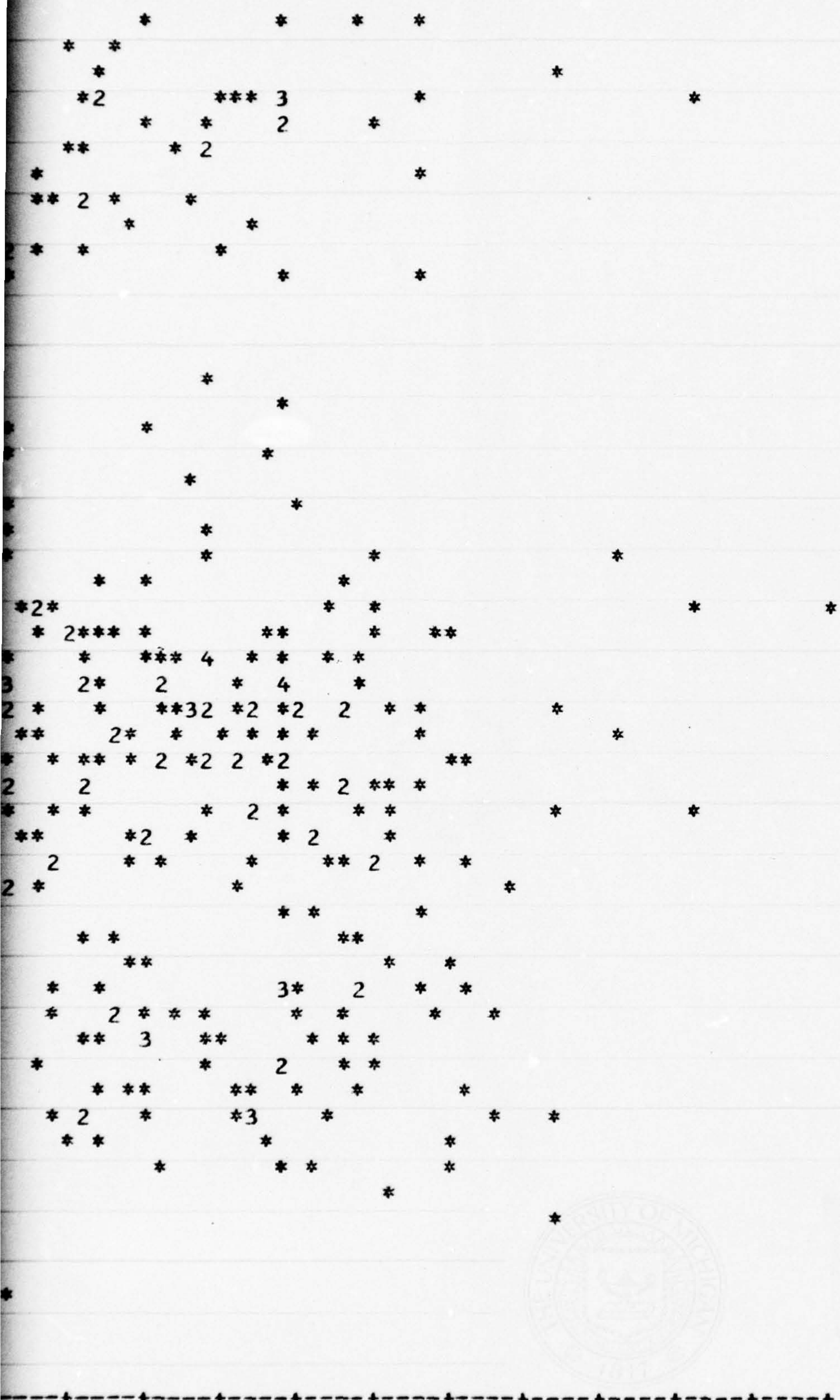

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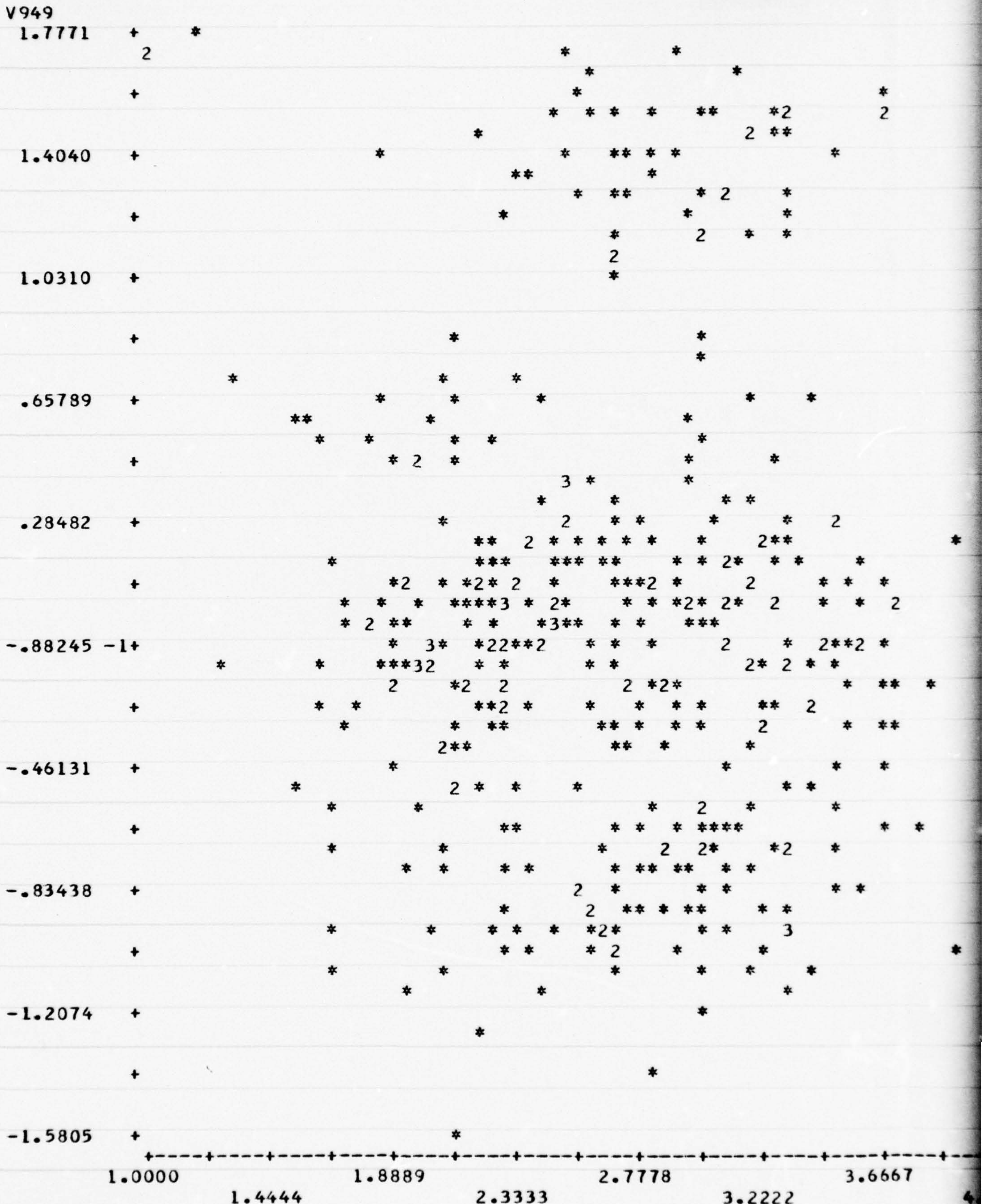

B-118

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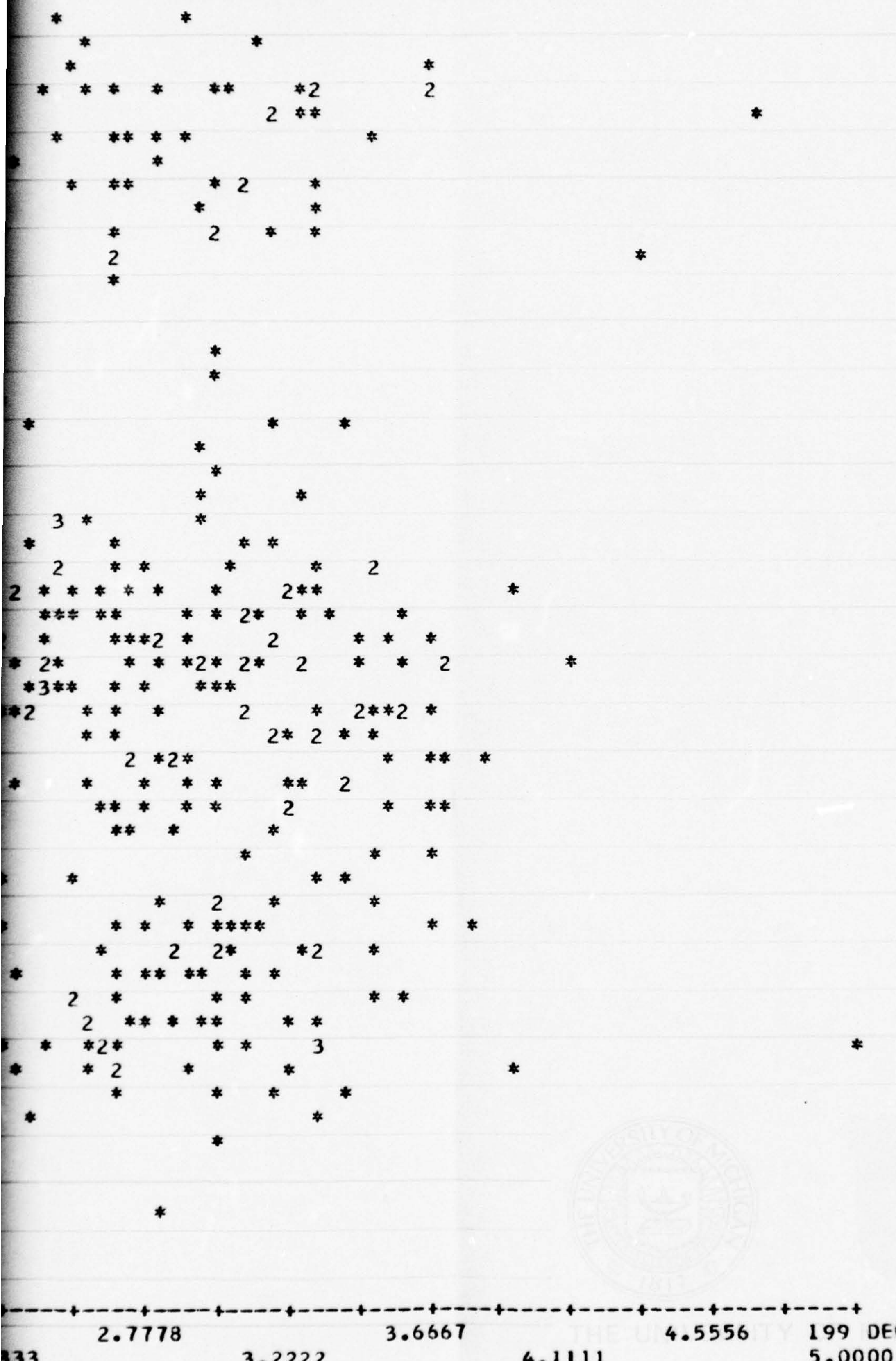

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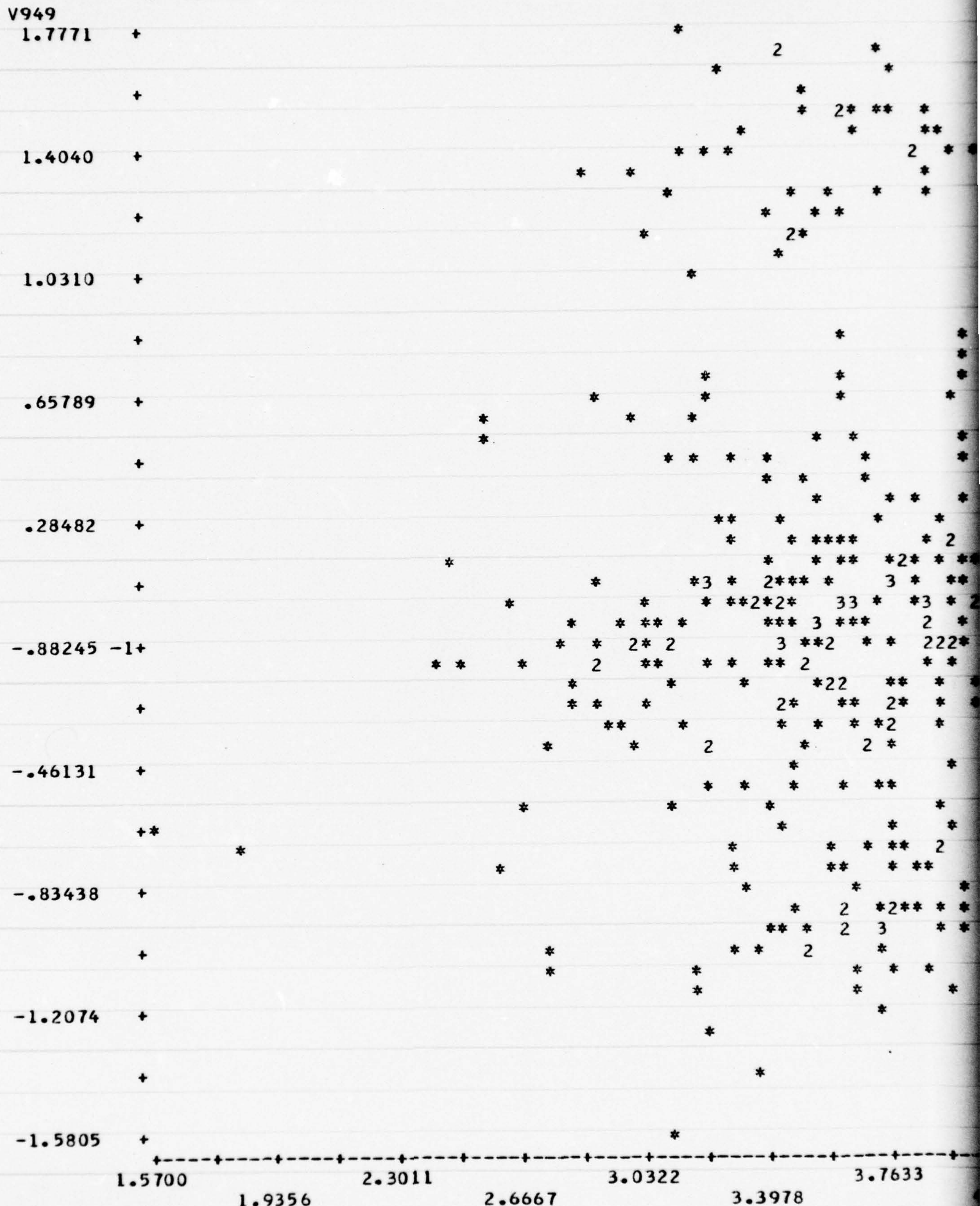

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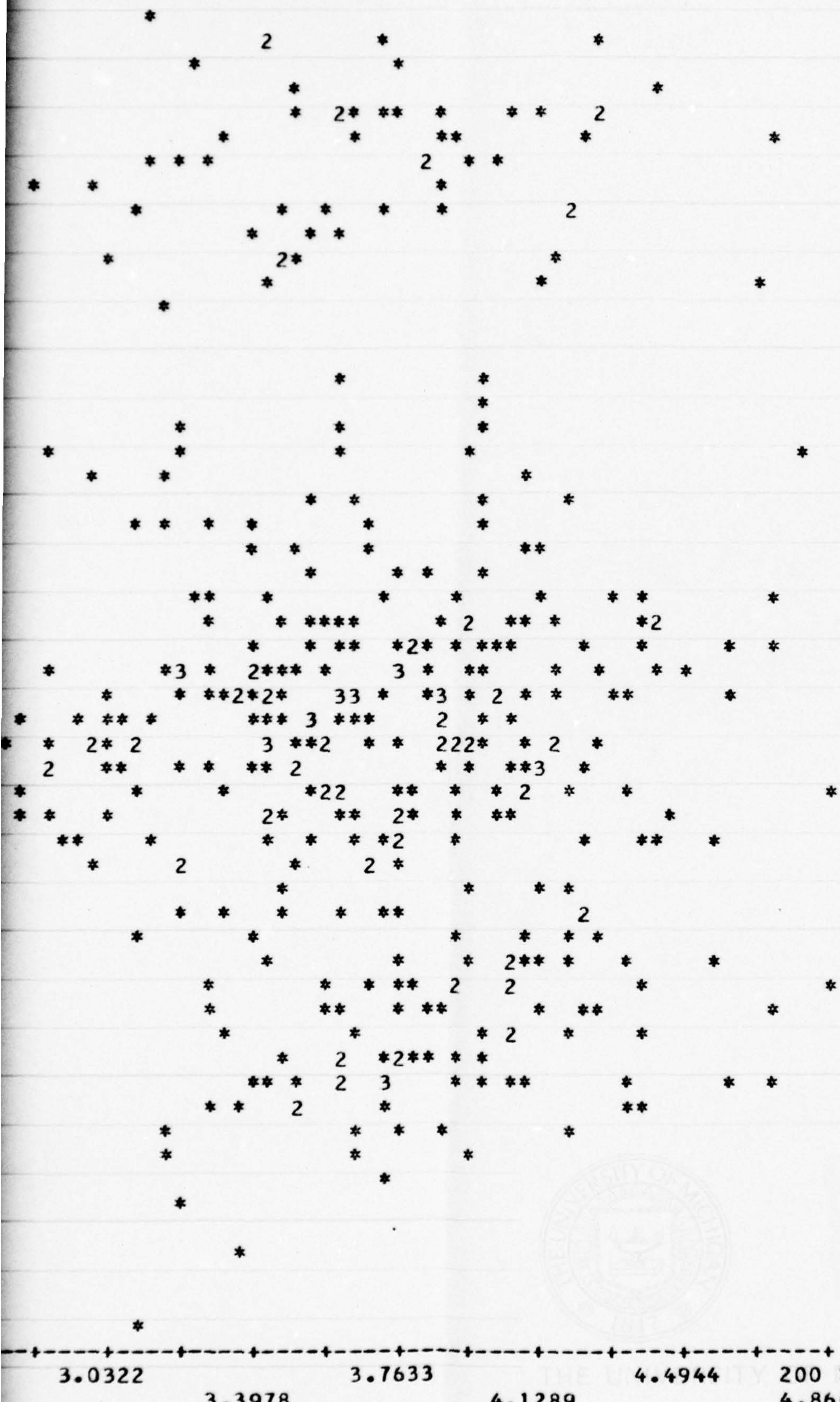

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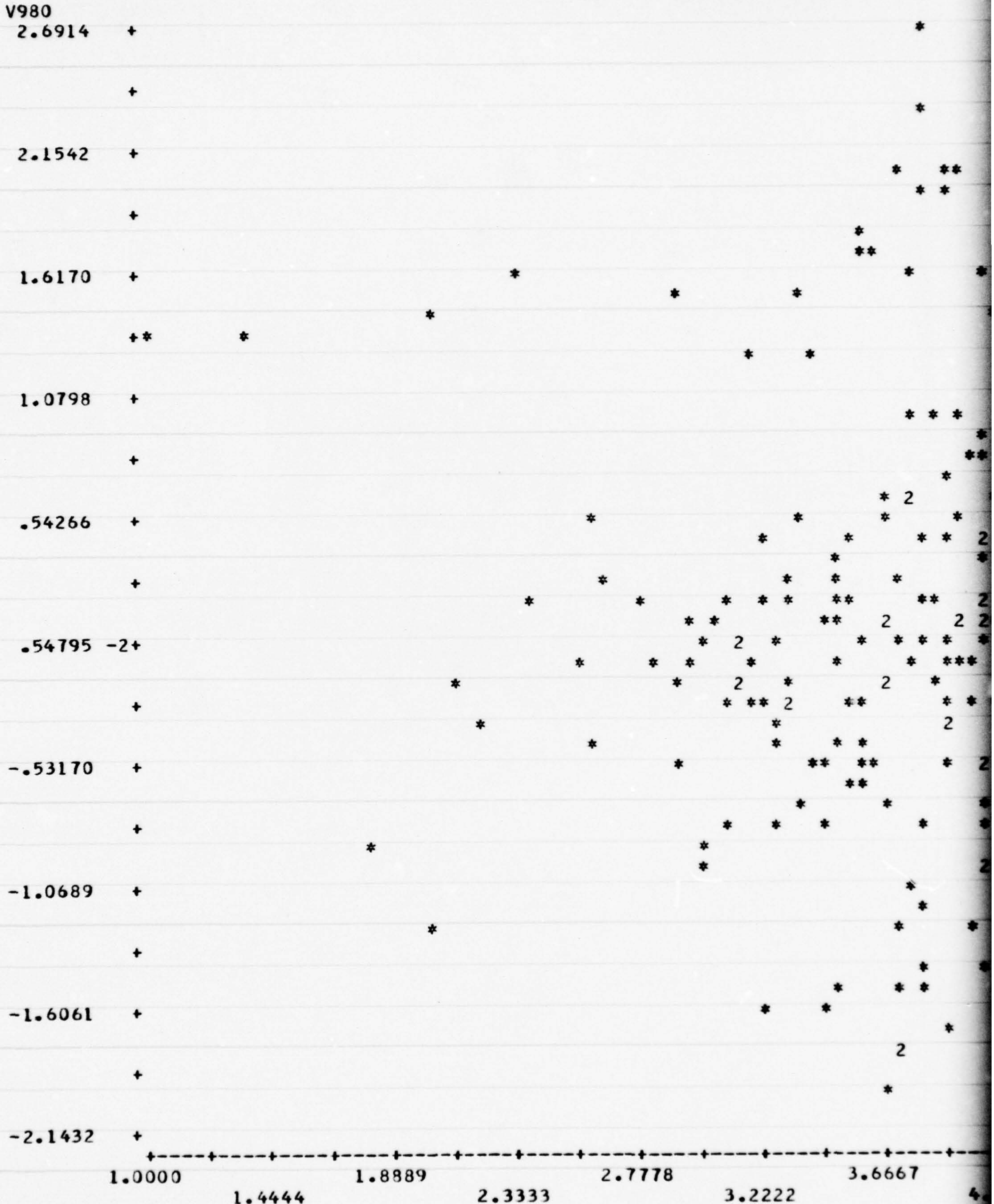

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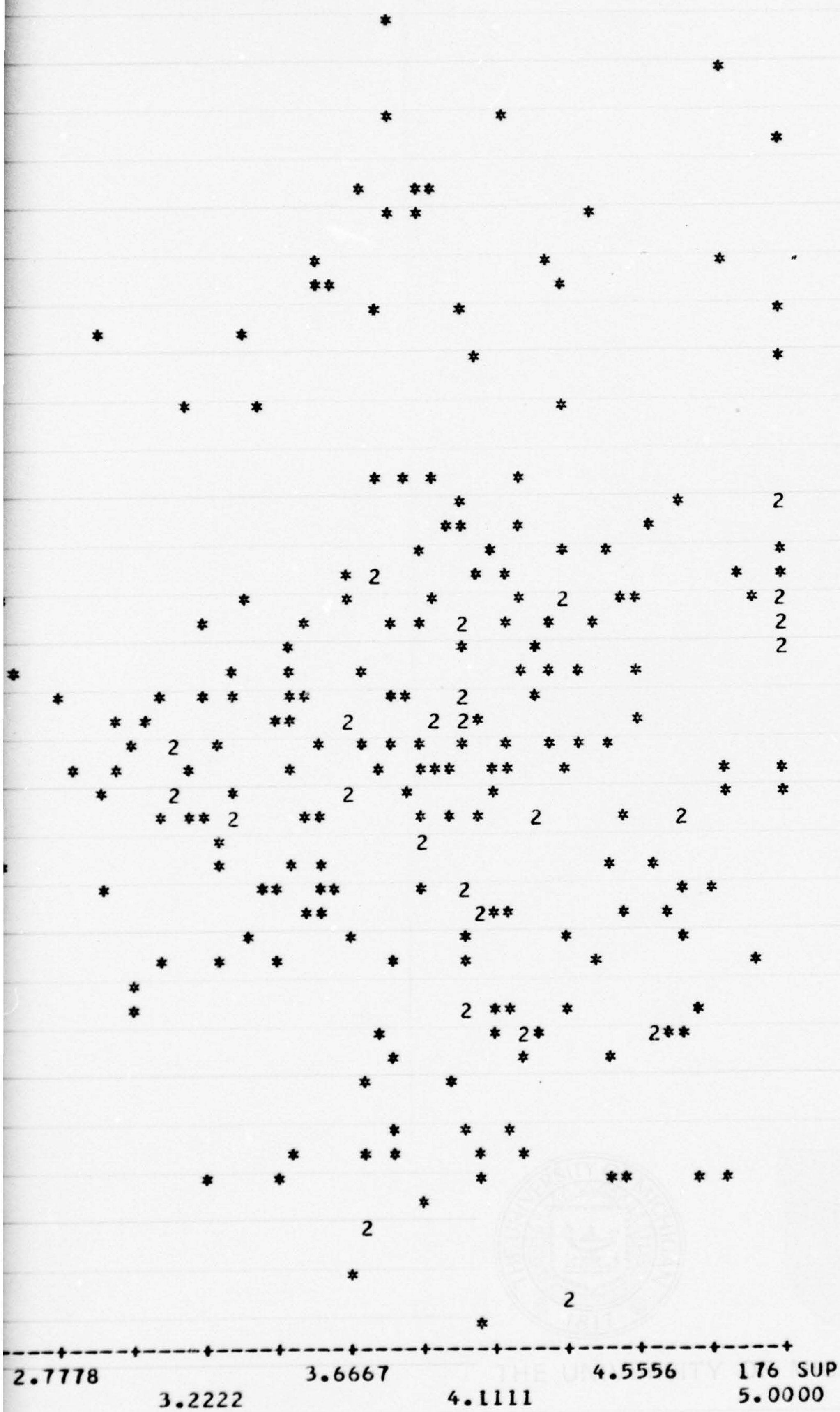

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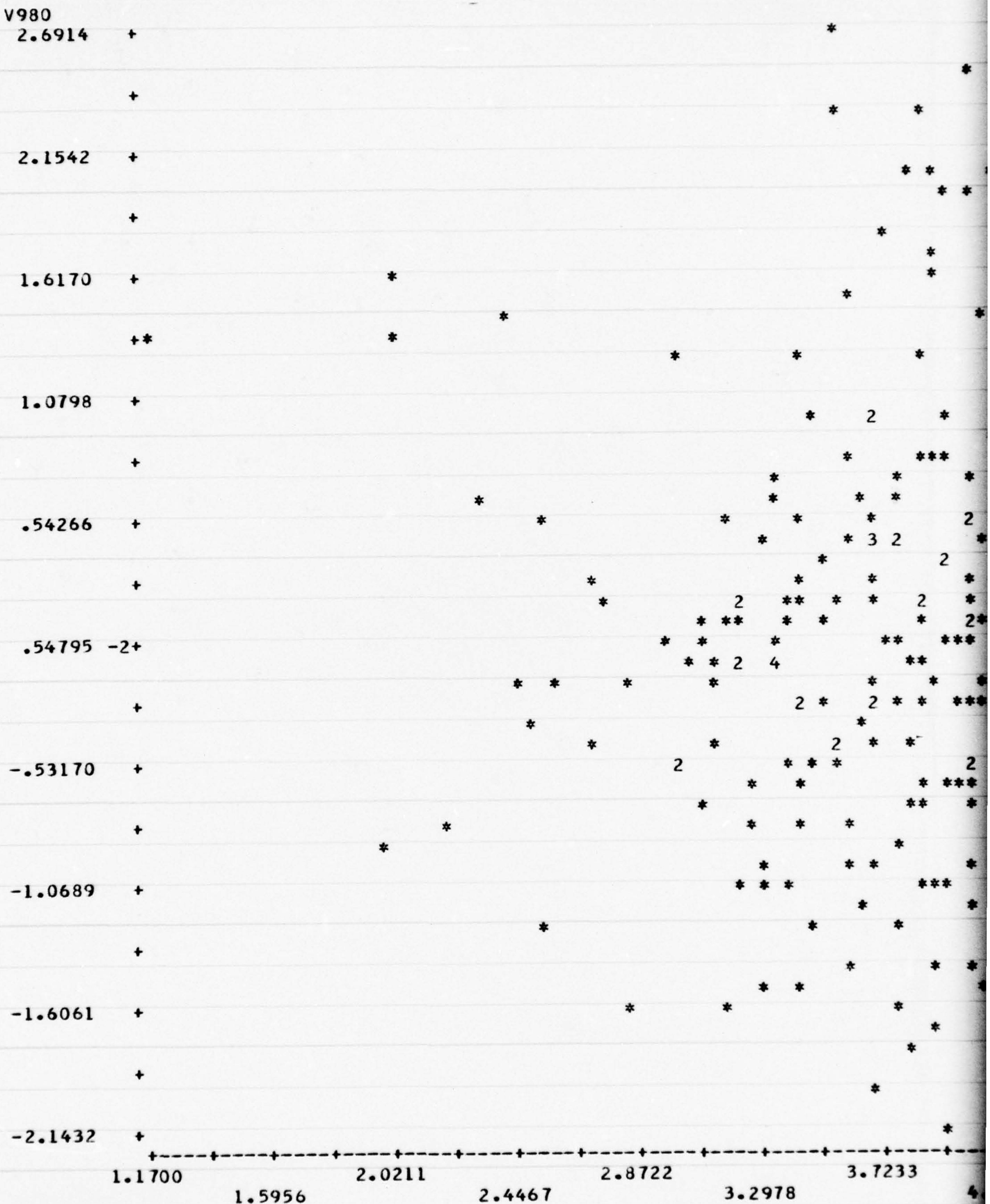

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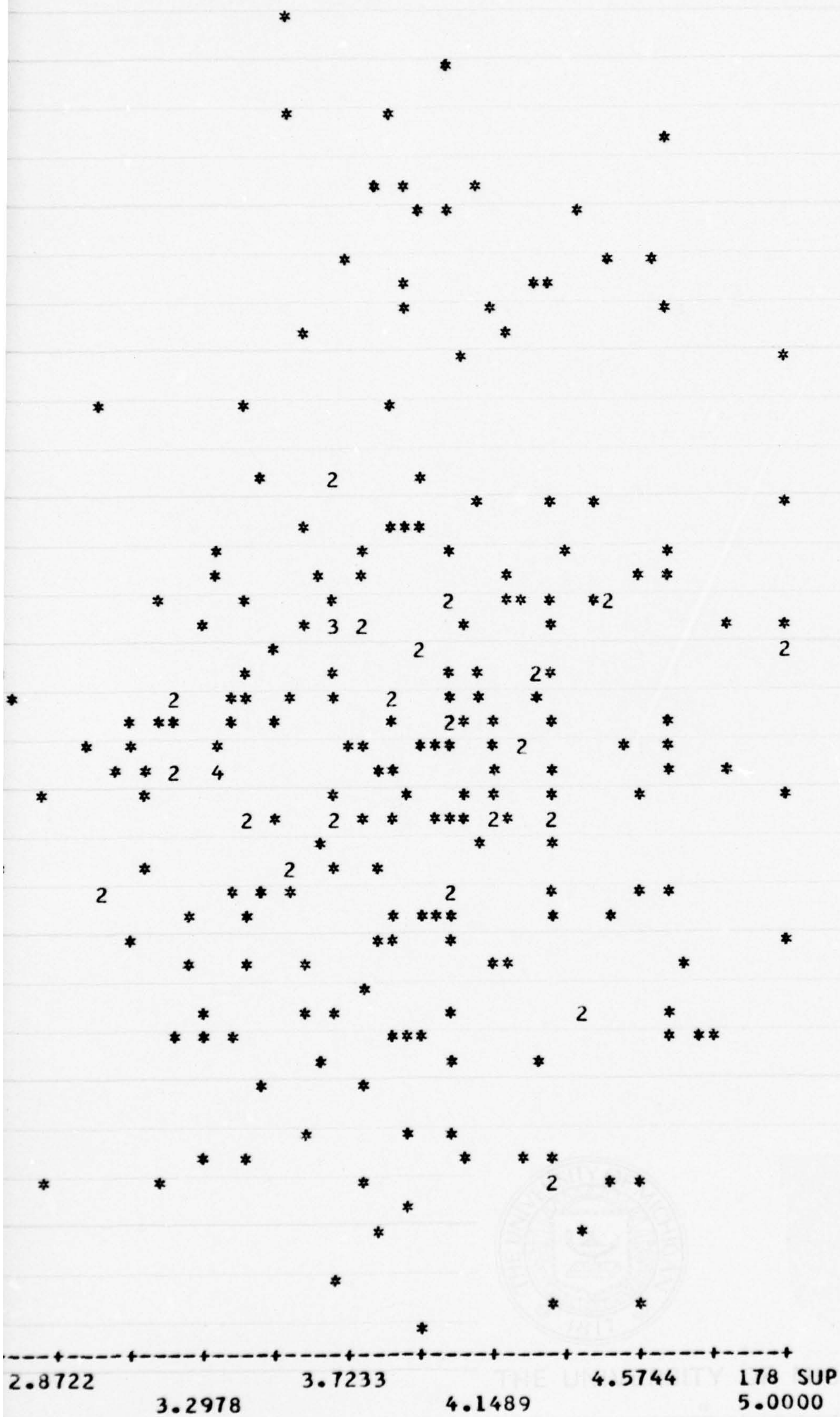

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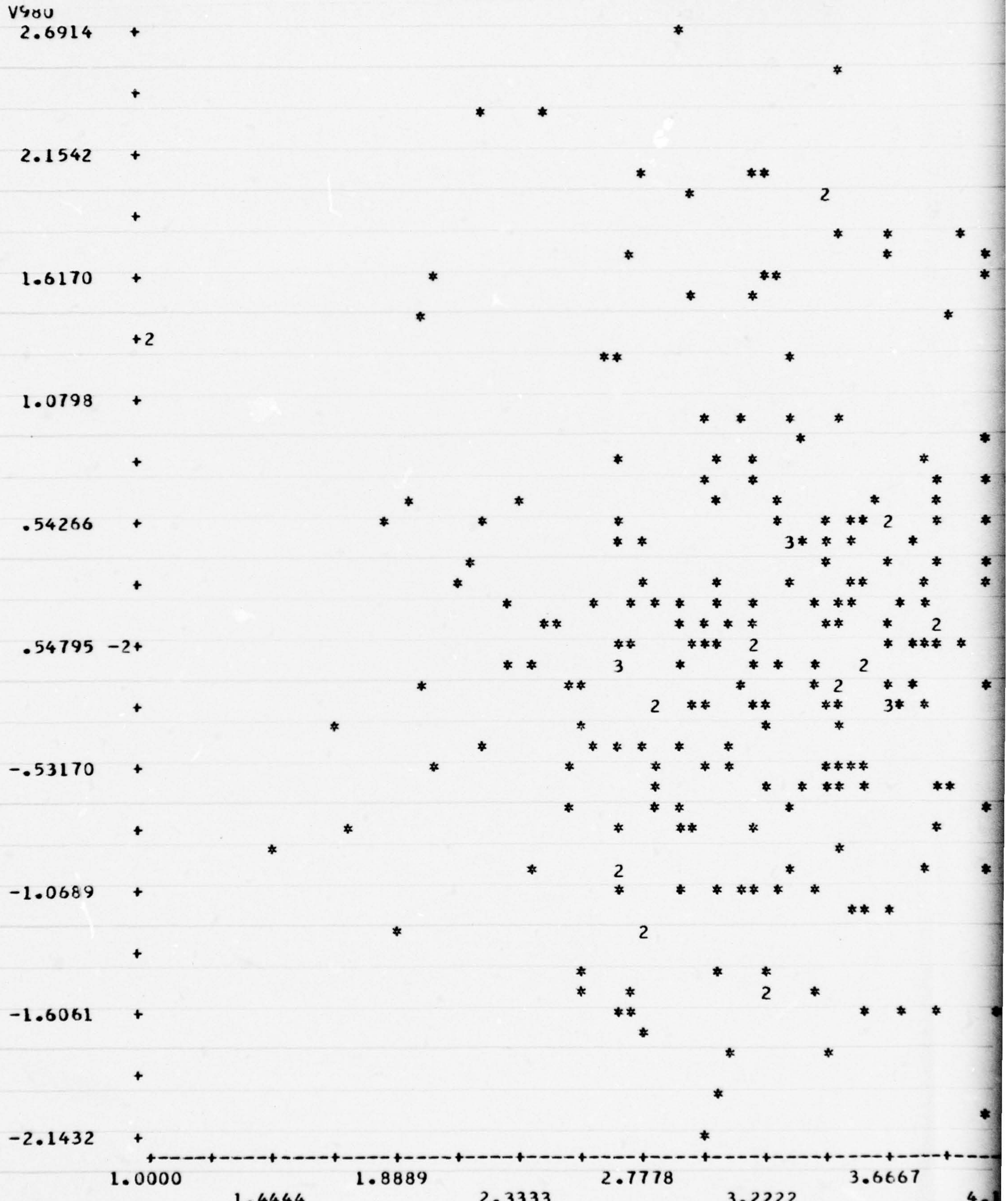

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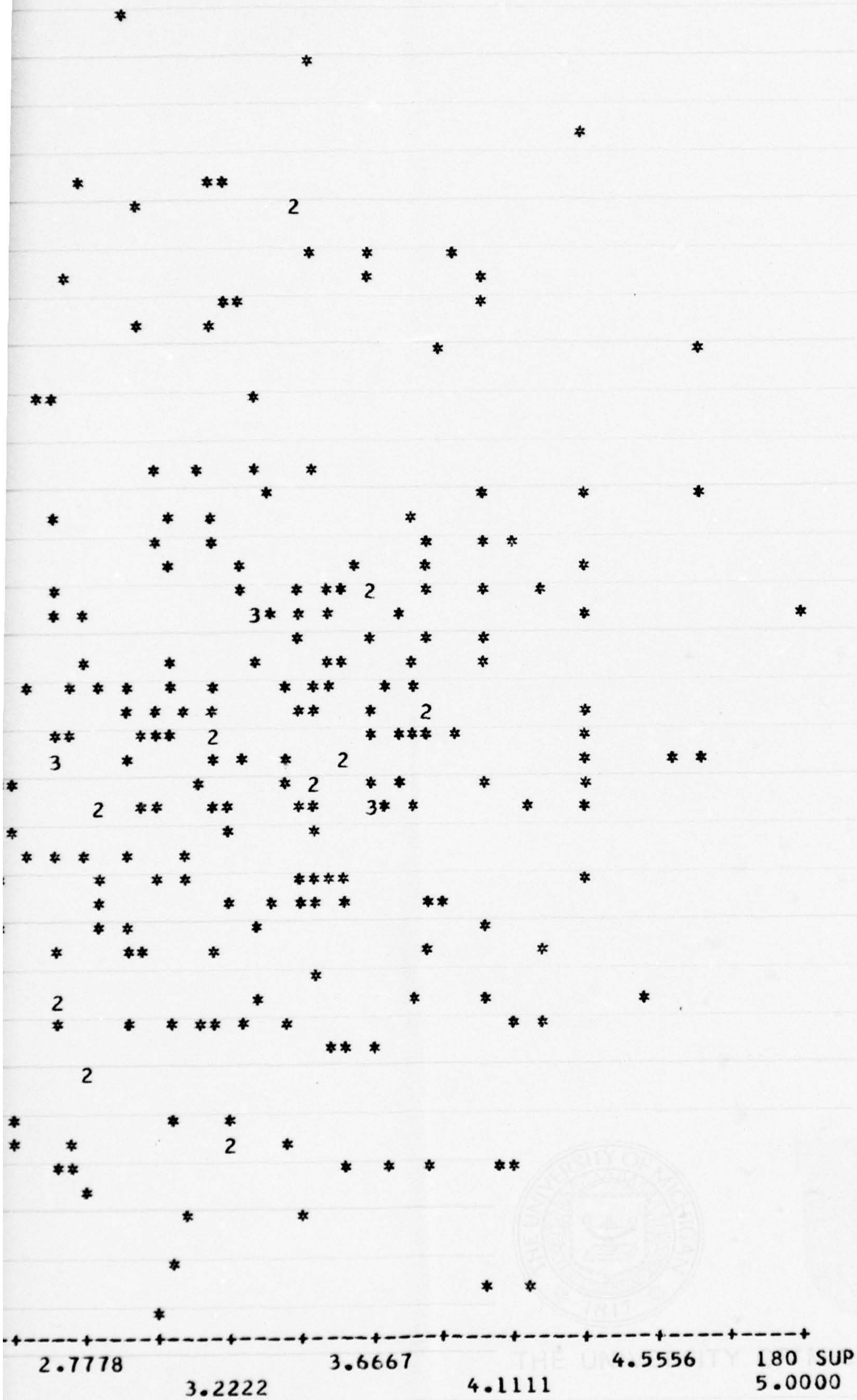

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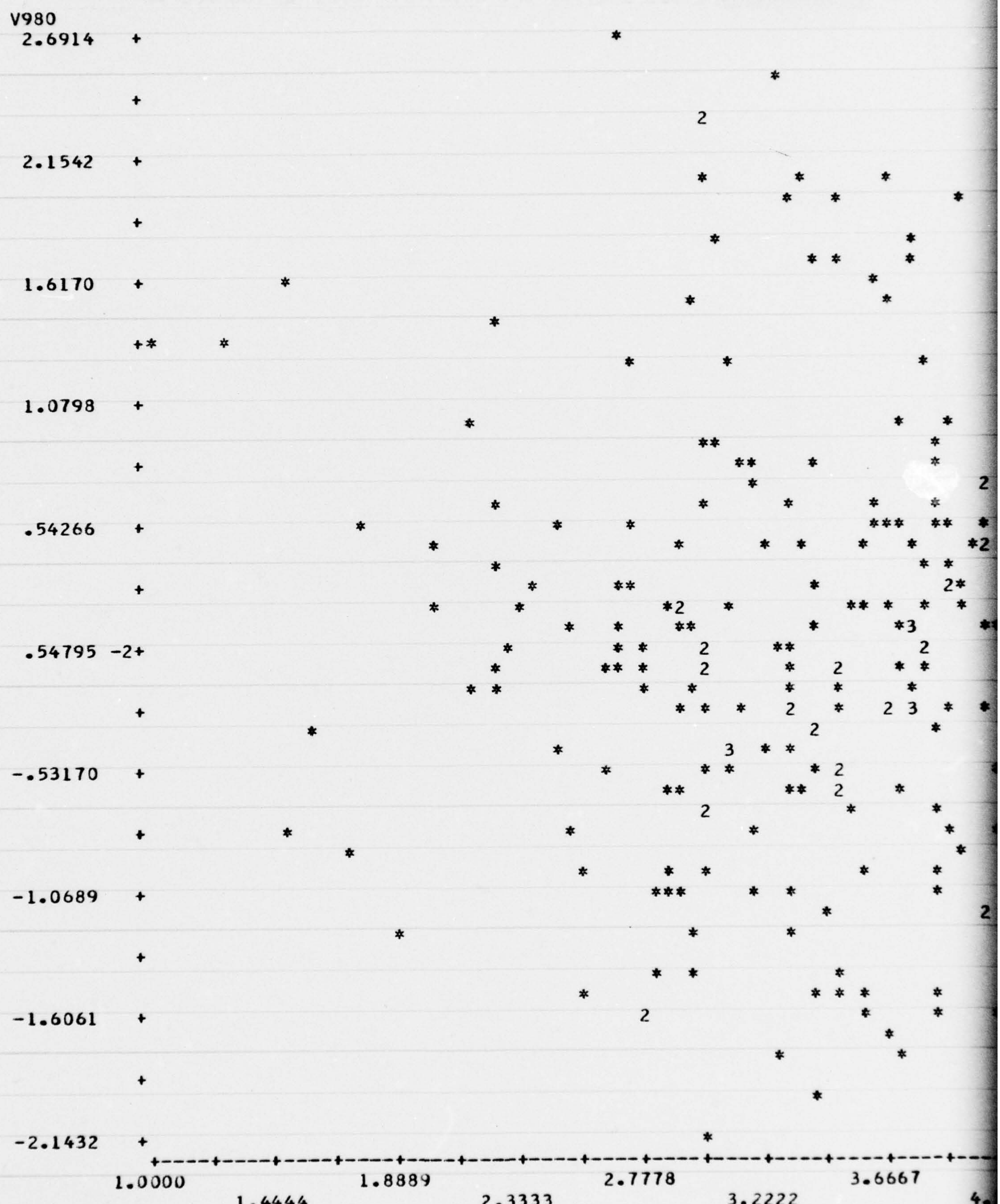

B-123

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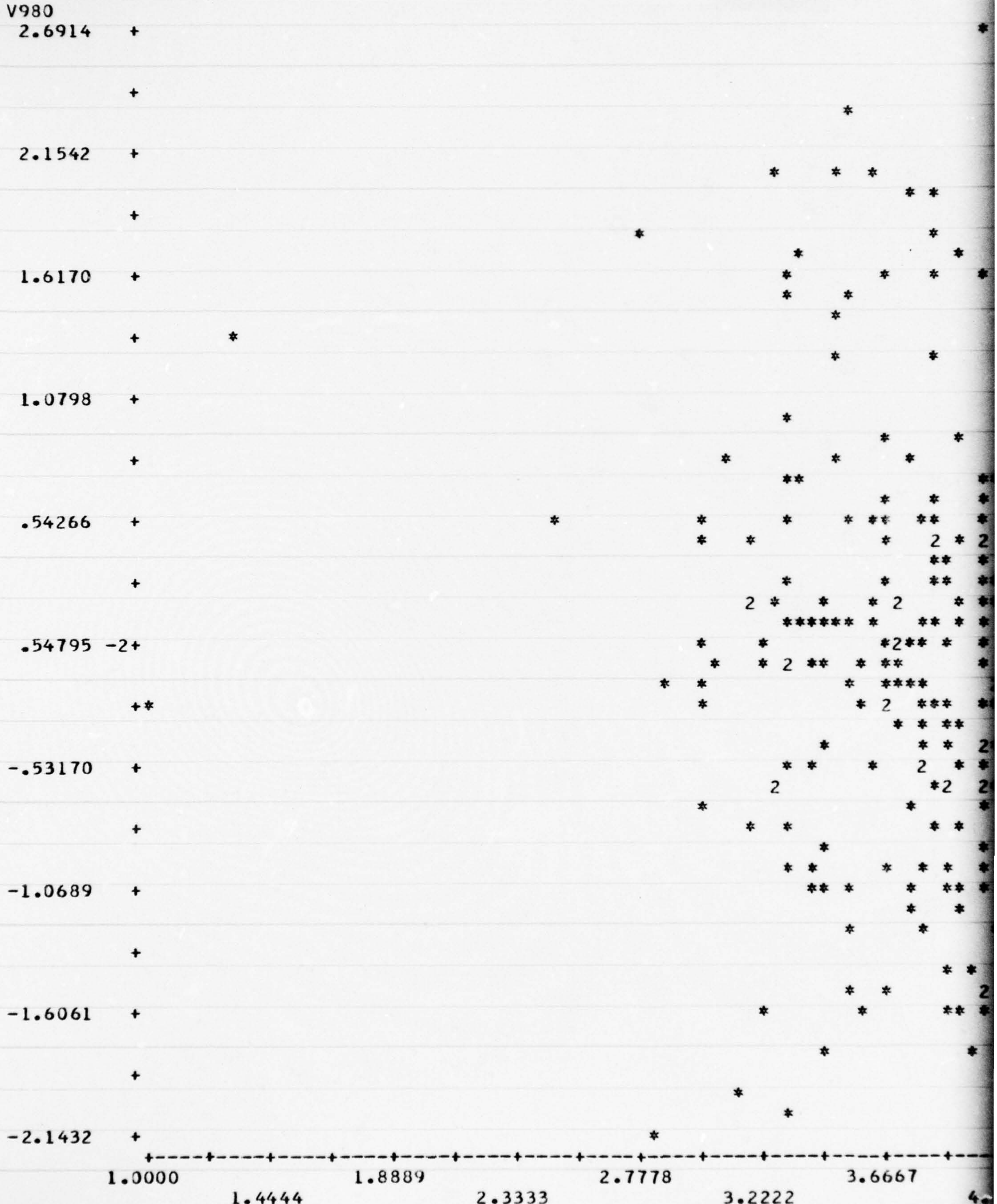

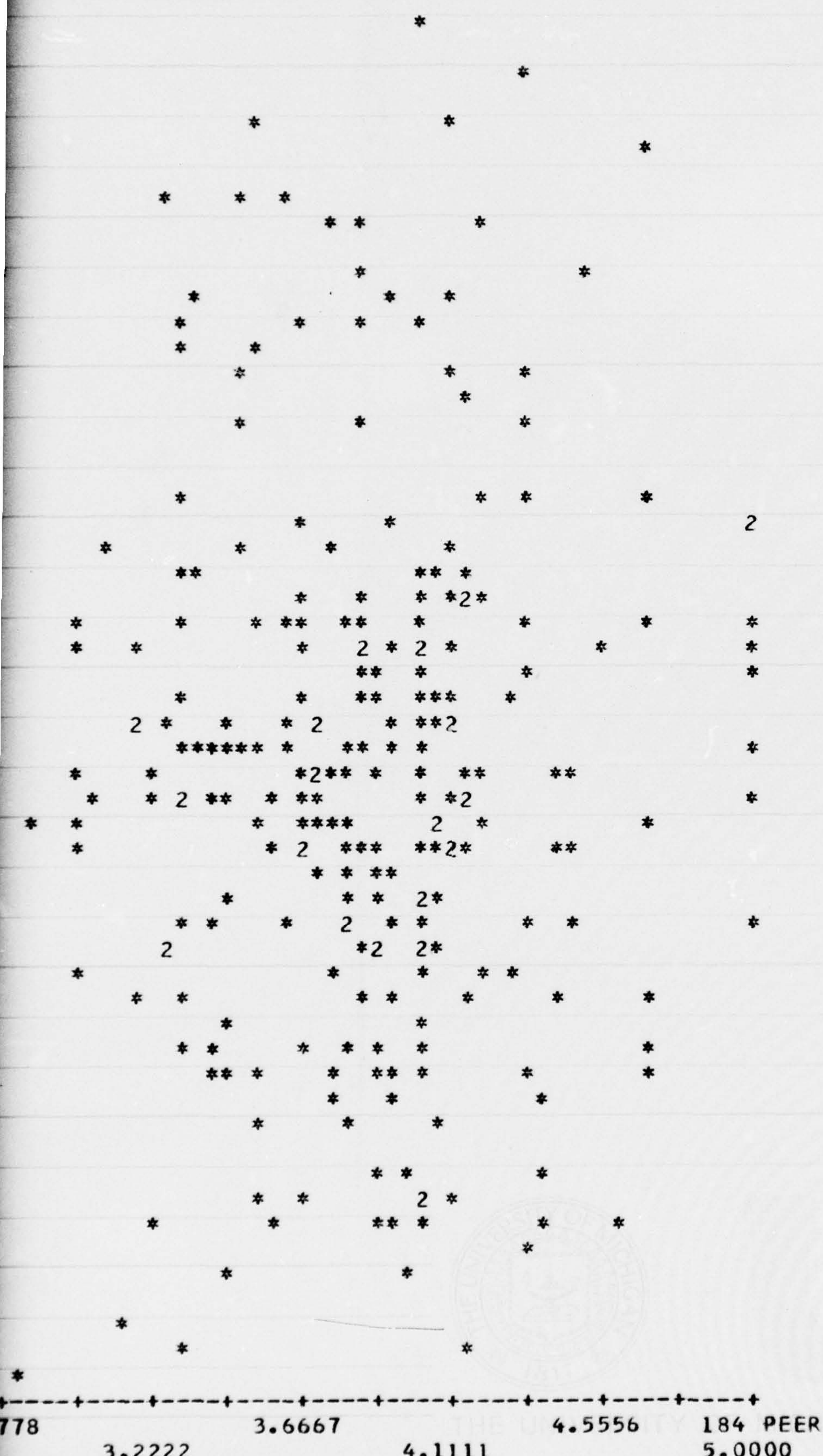
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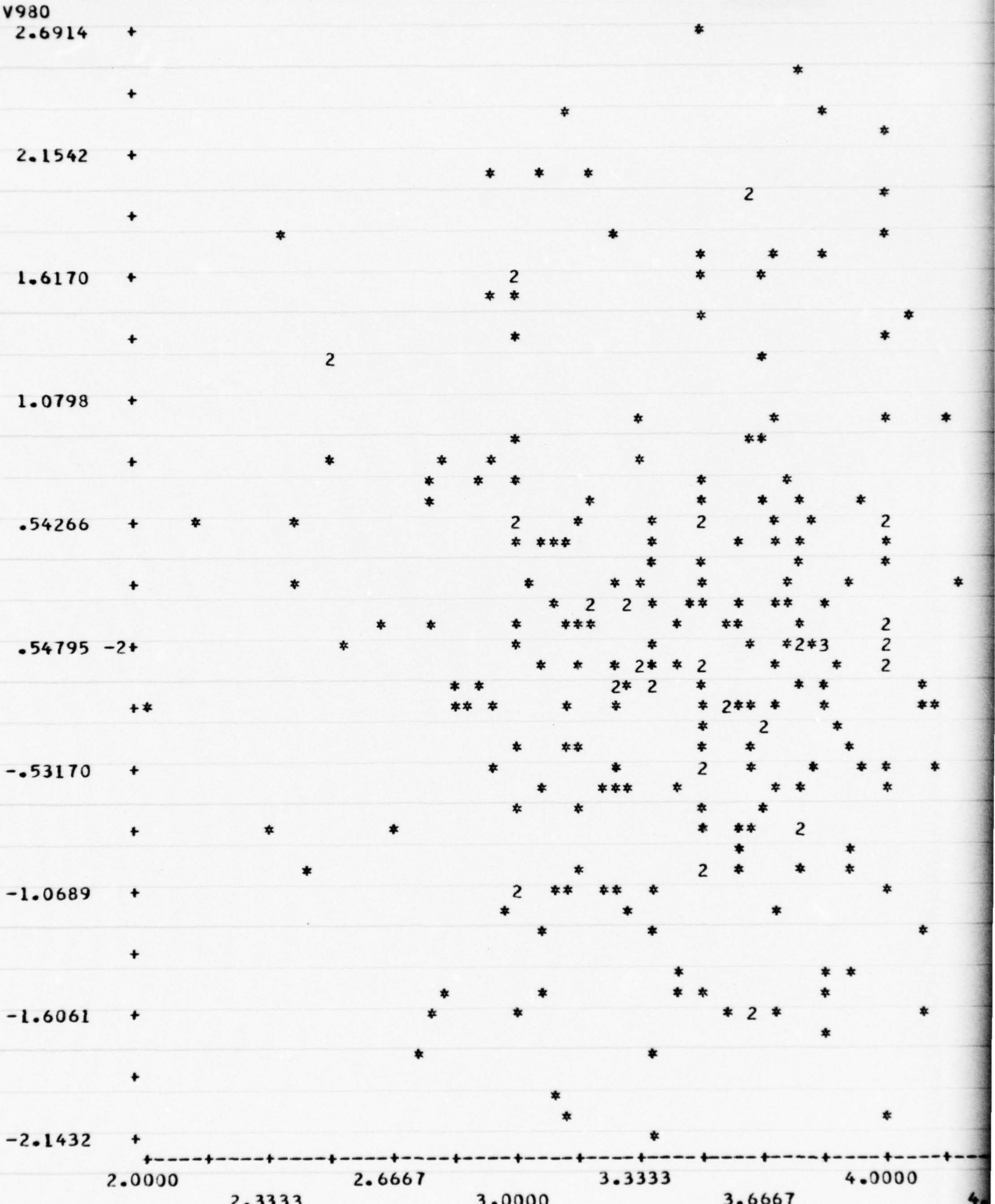
3.6667
4.1111
4.5556
184 PEER
5.0000
2

SCATTER PLOT



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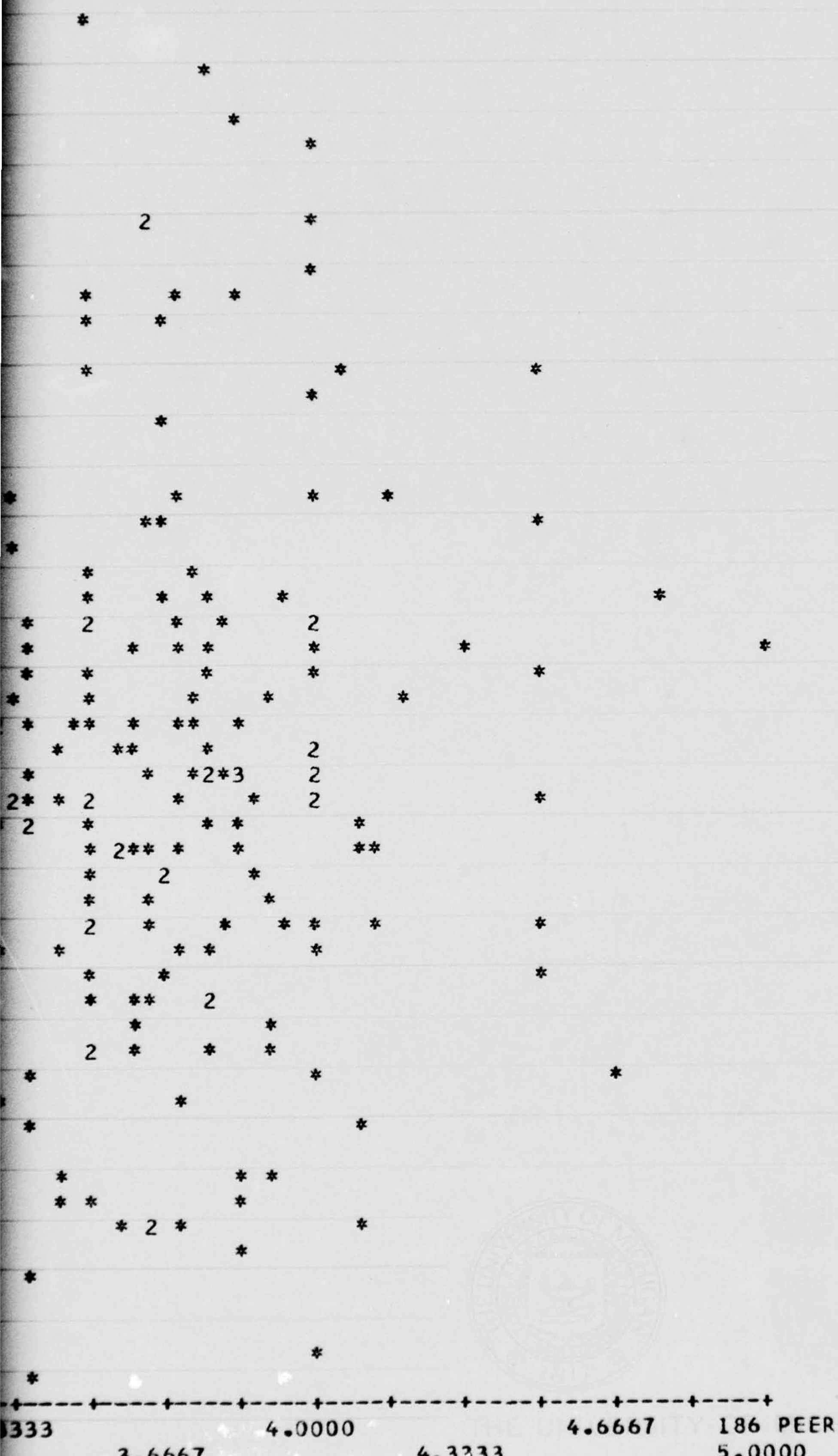

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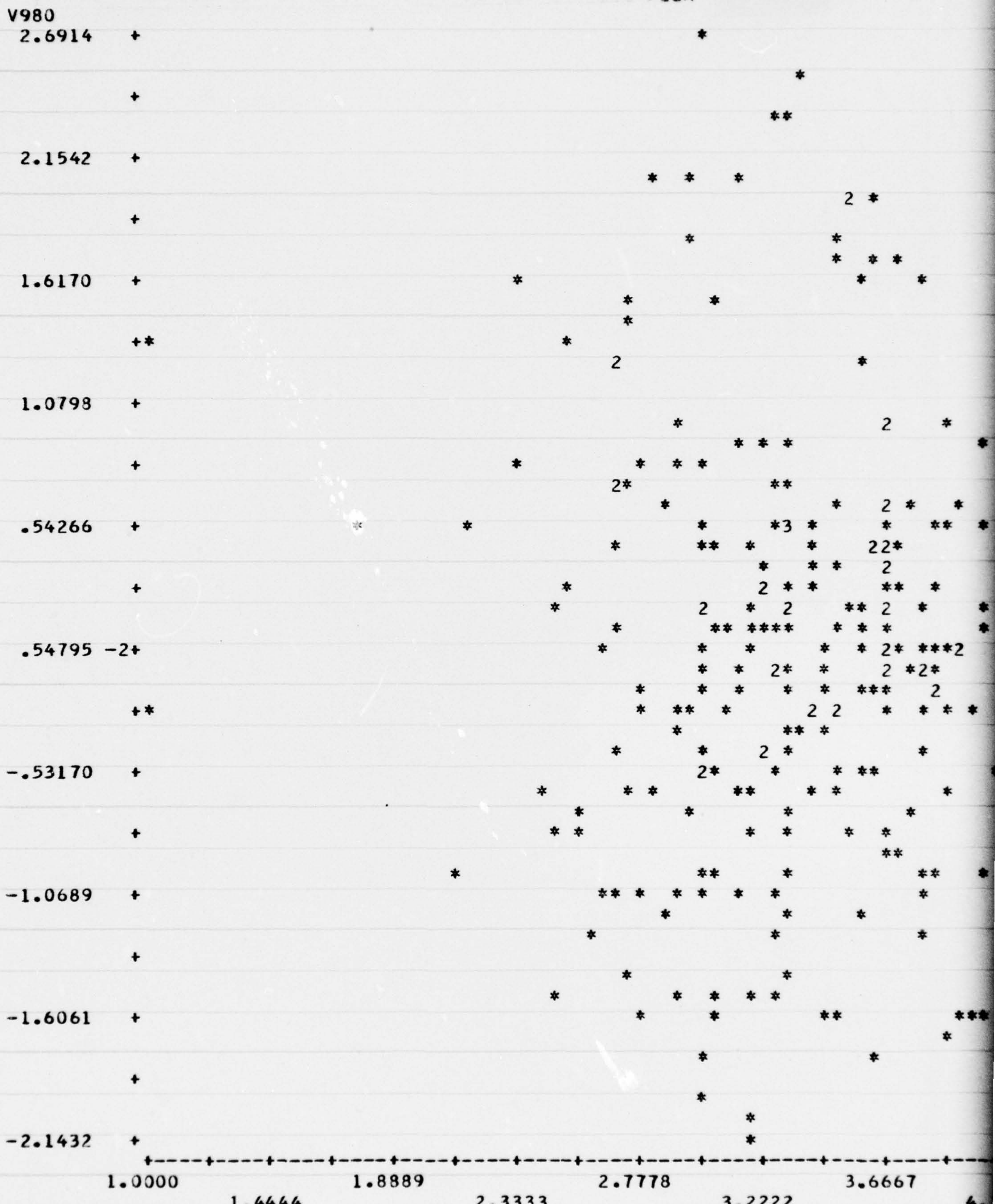

B-126

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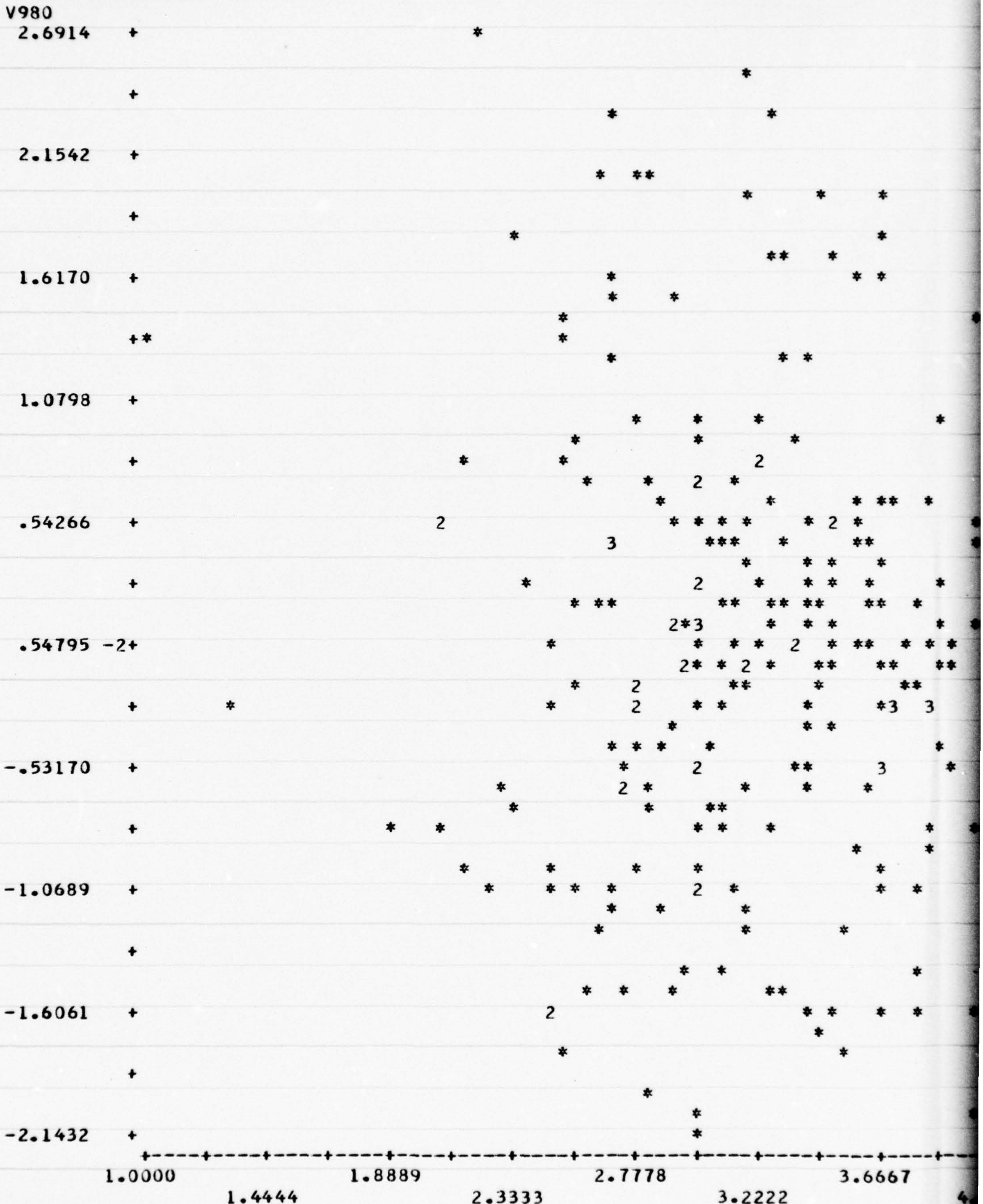

B-127

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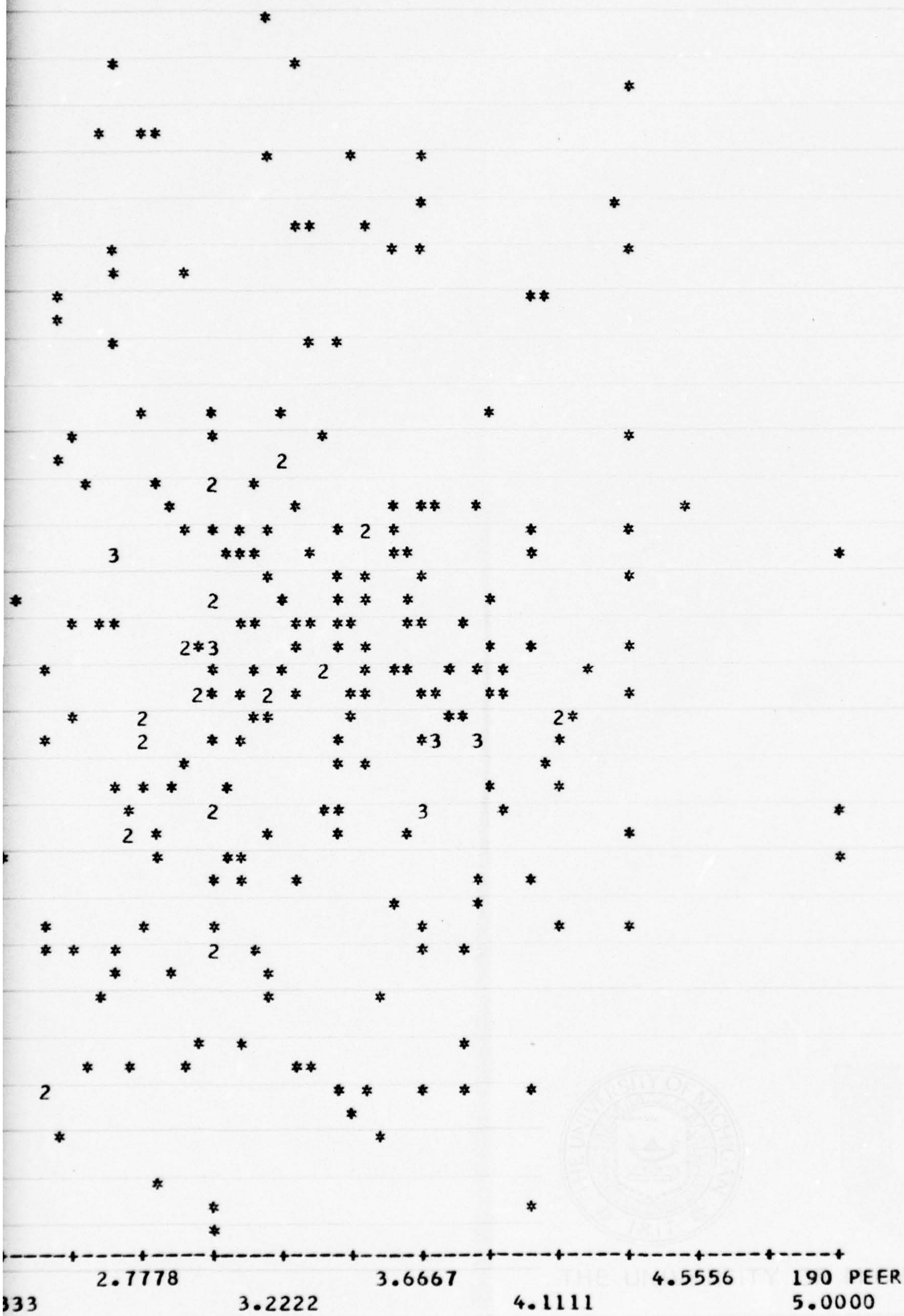

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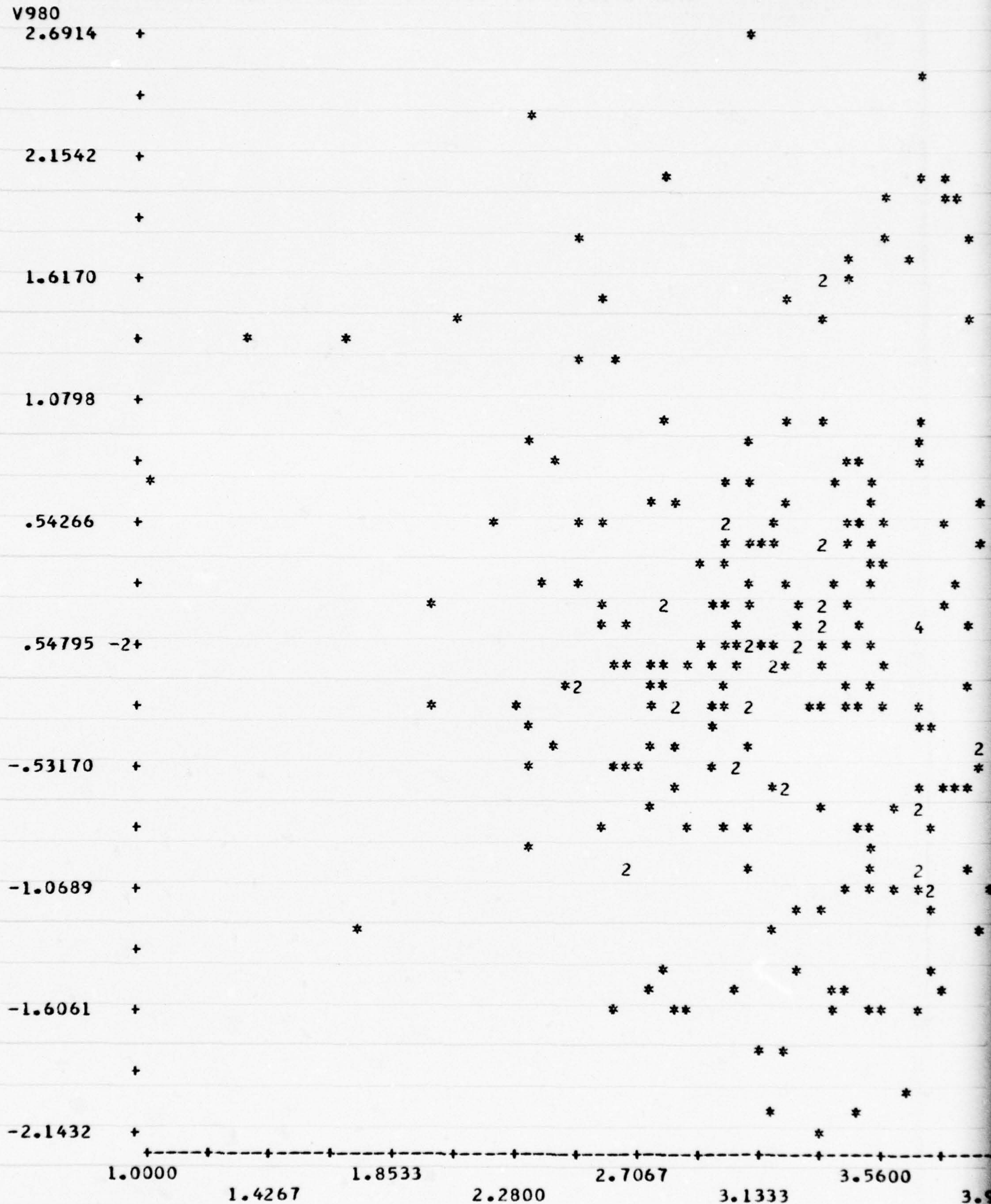

B-128

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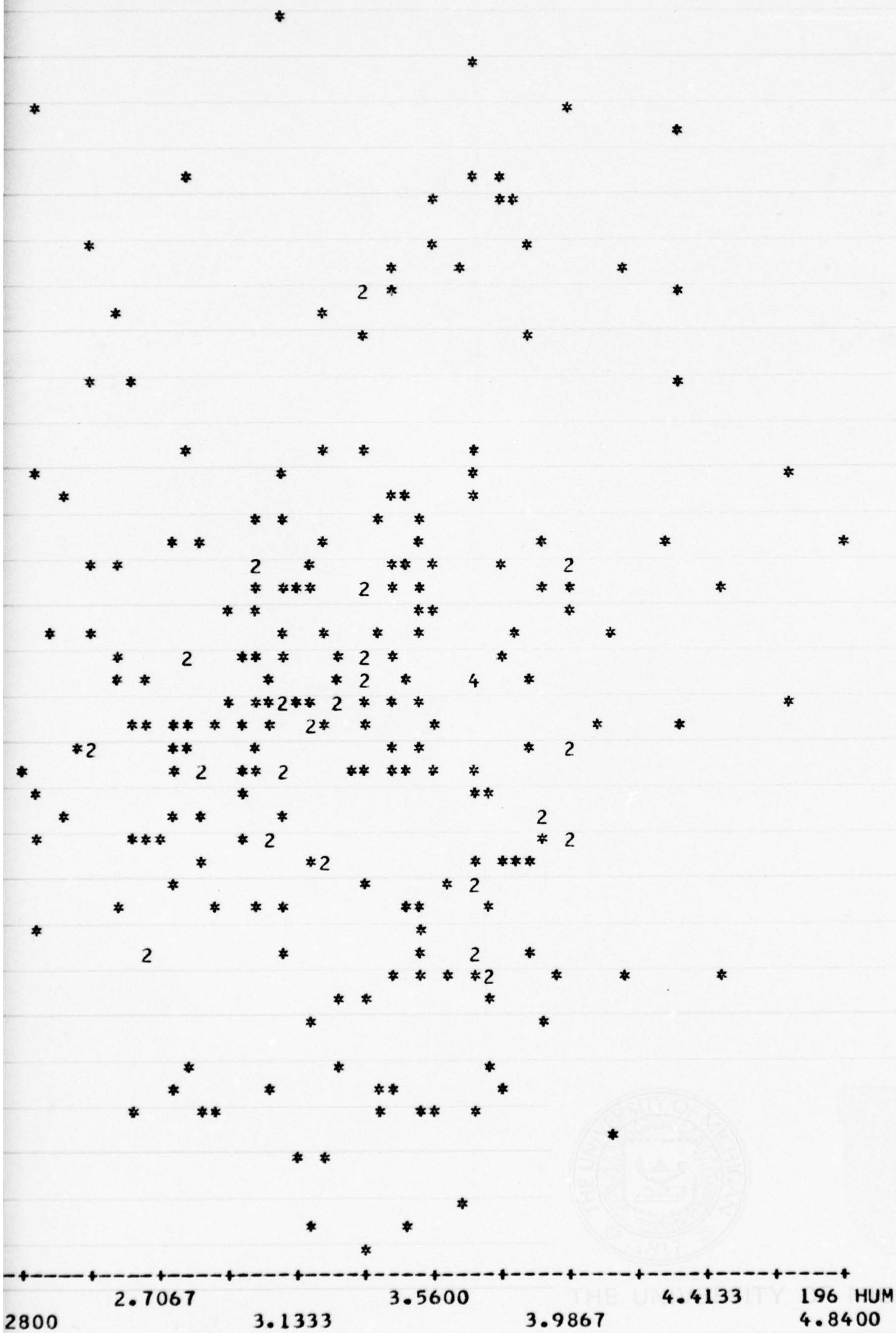

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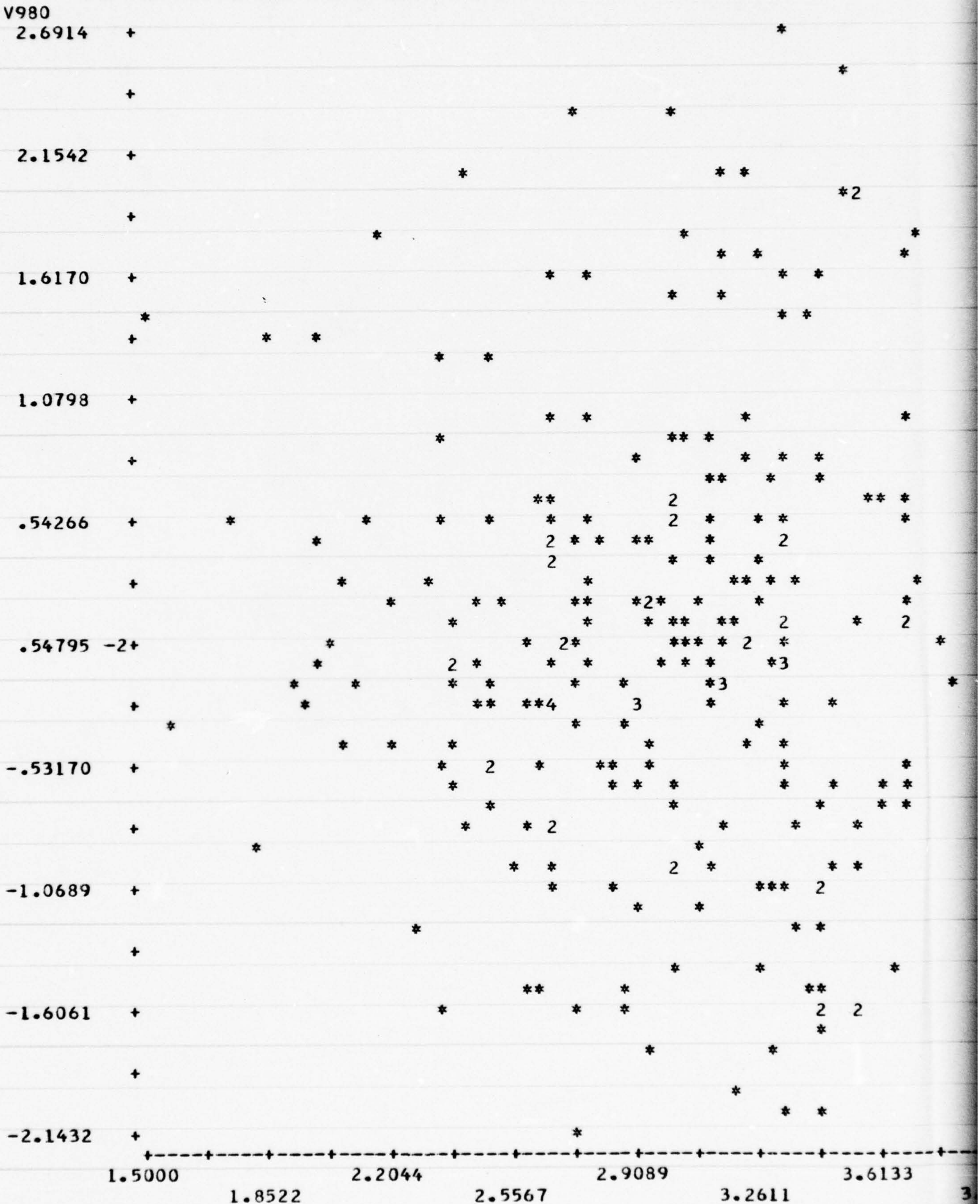

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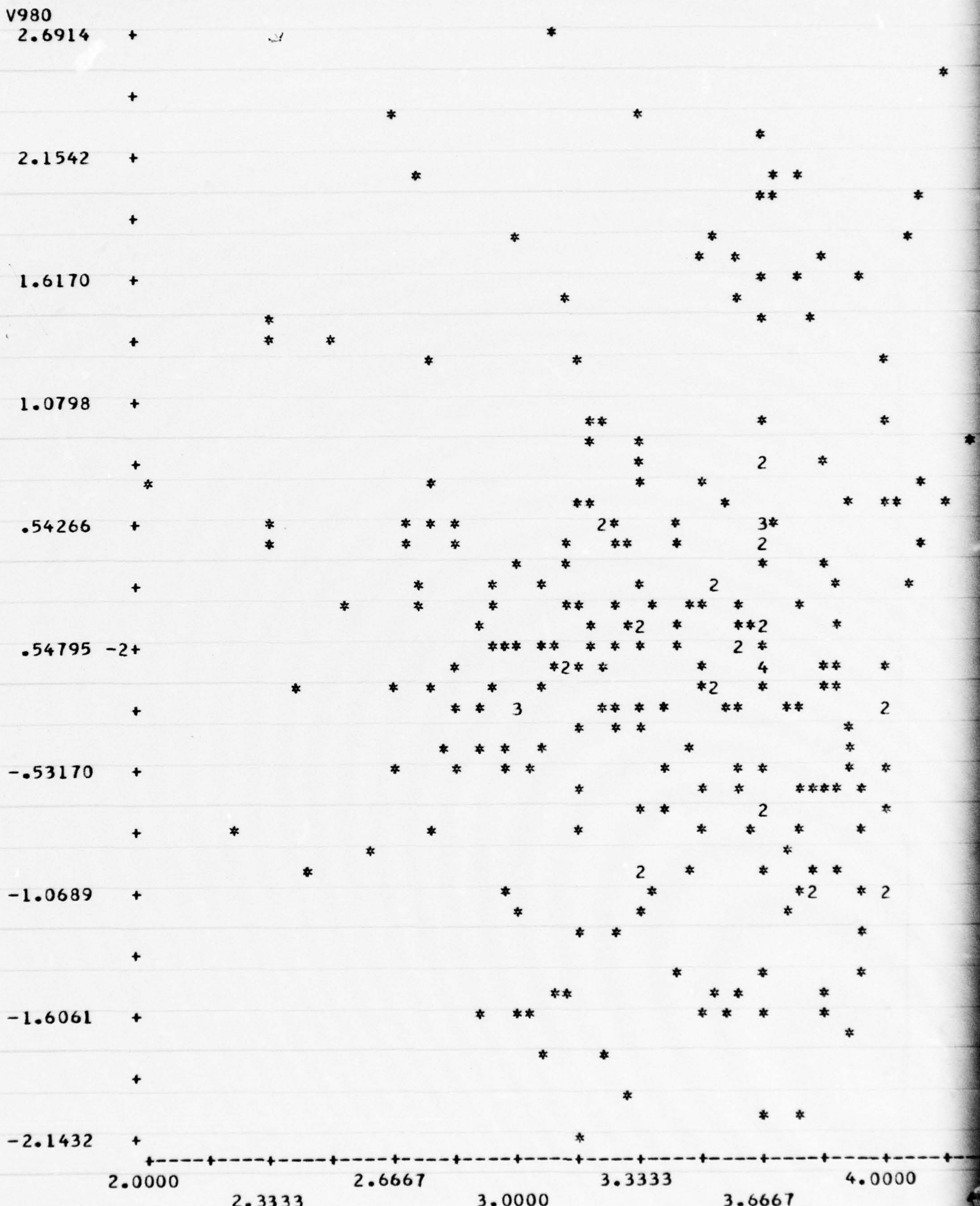

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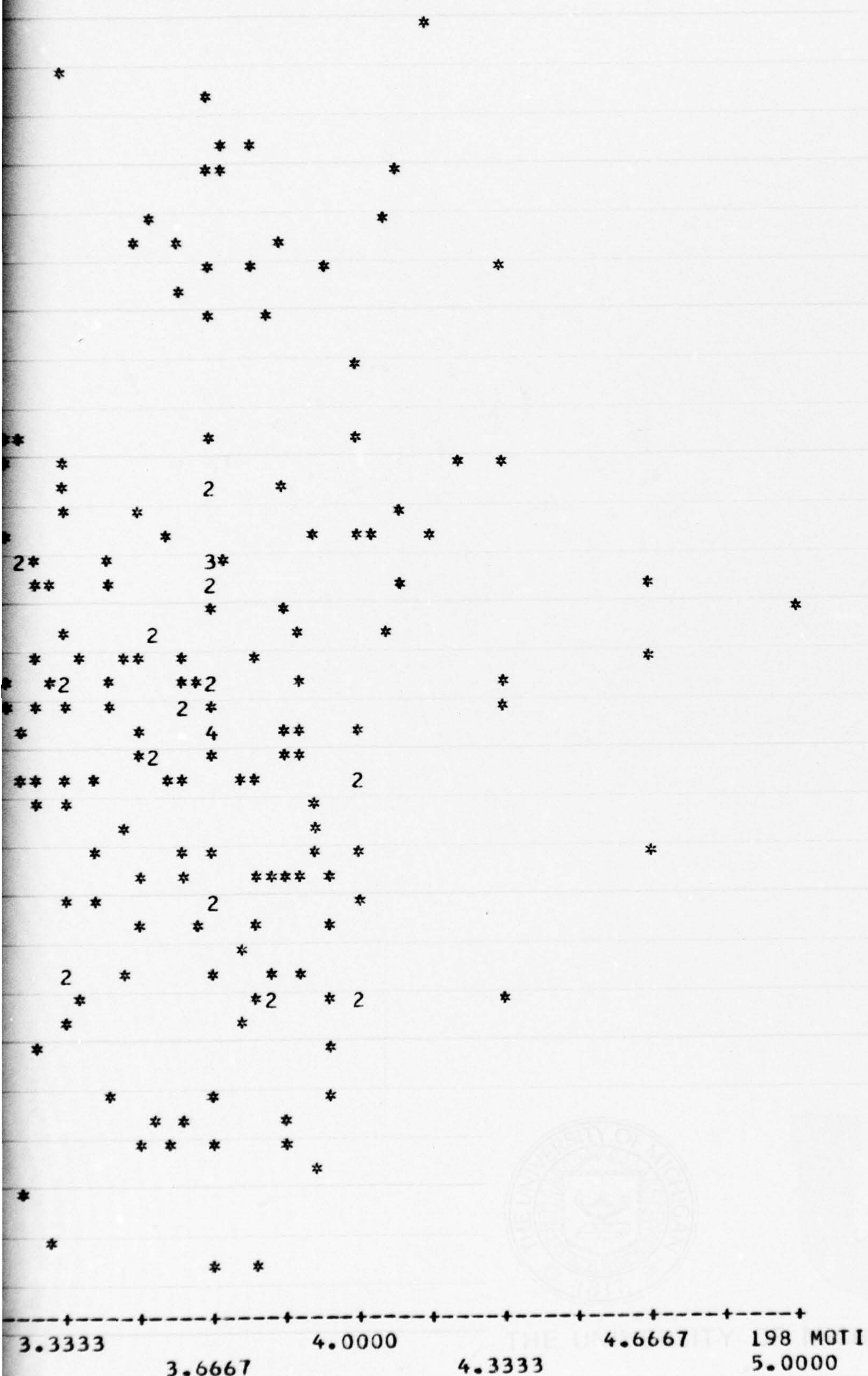

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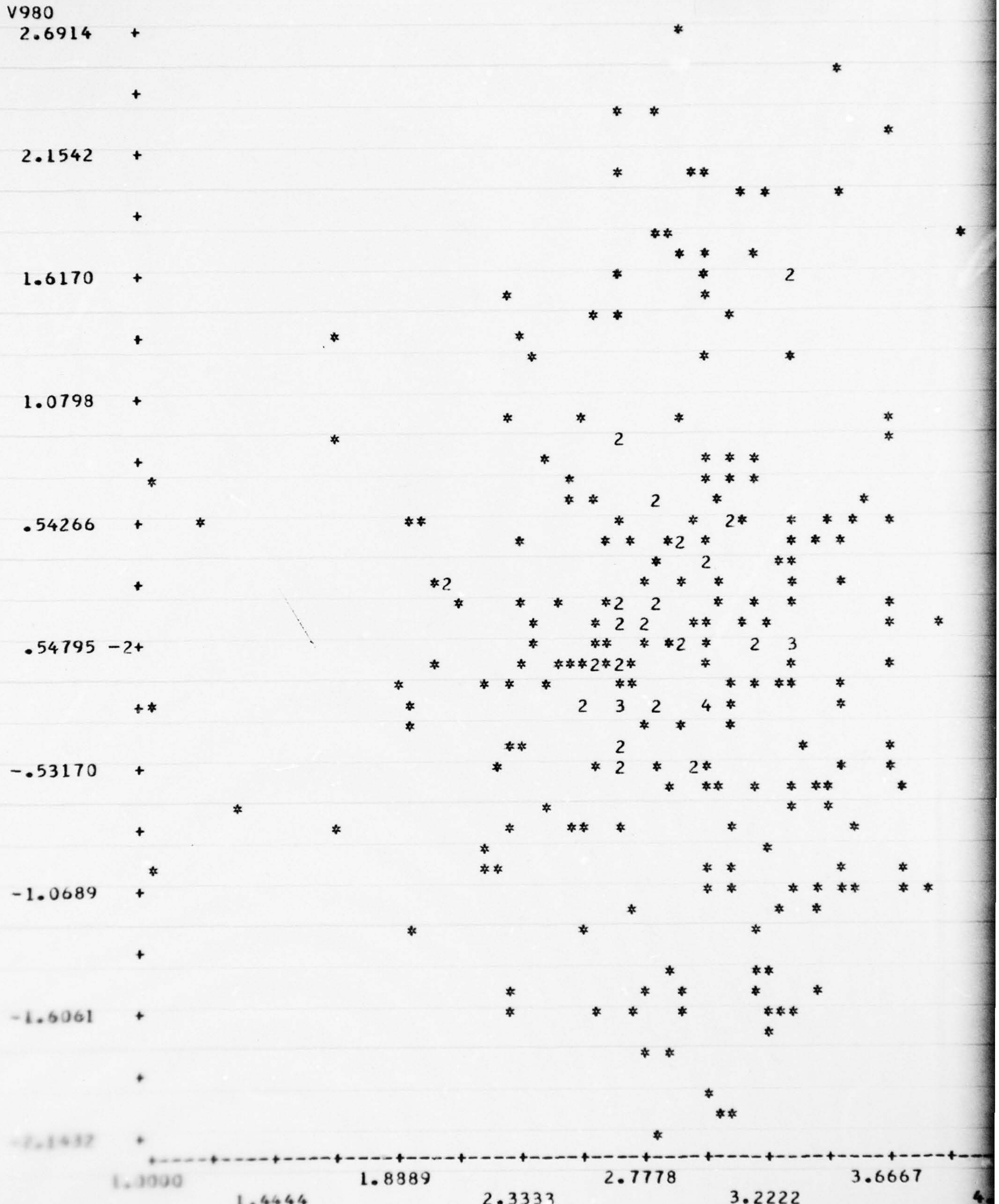

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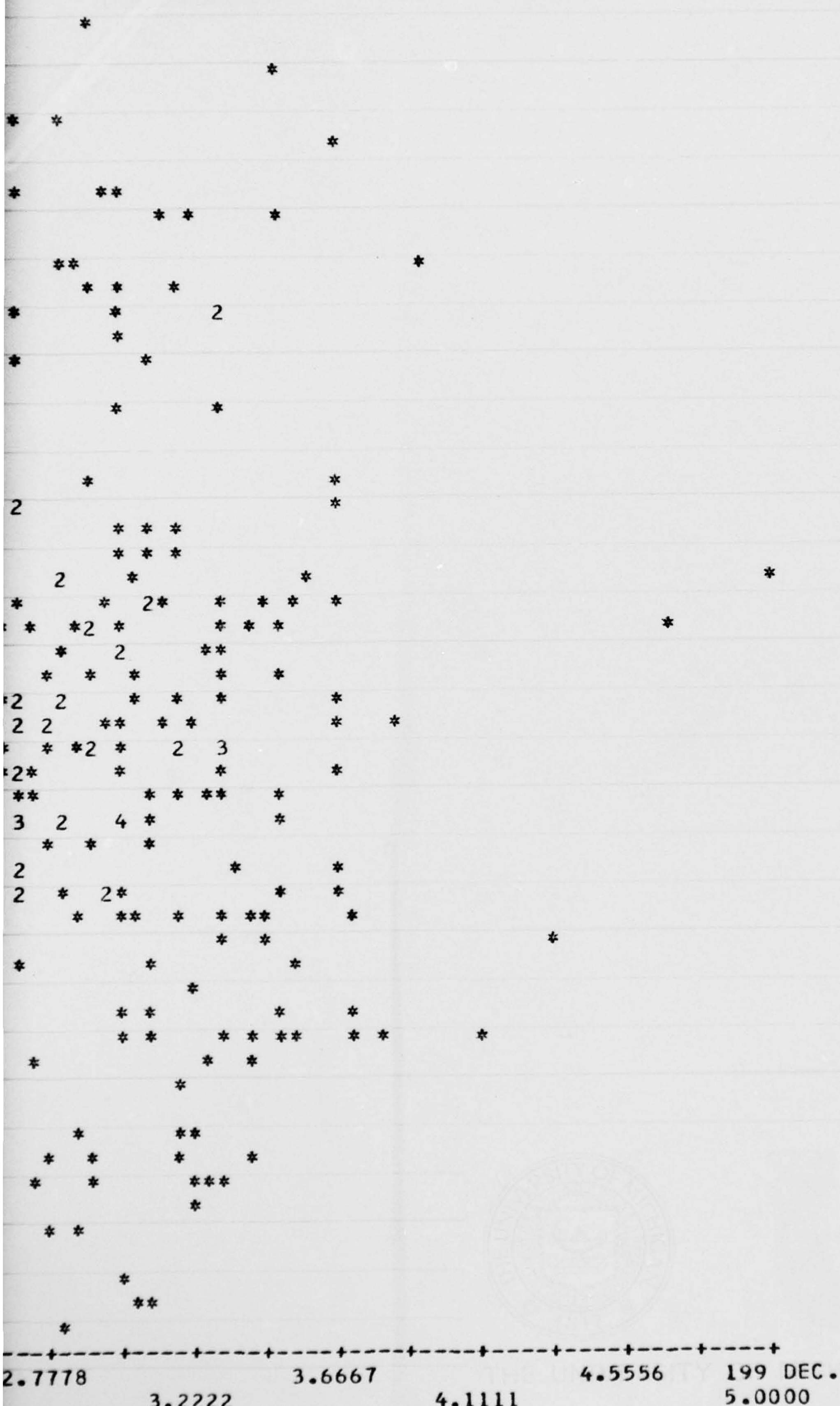

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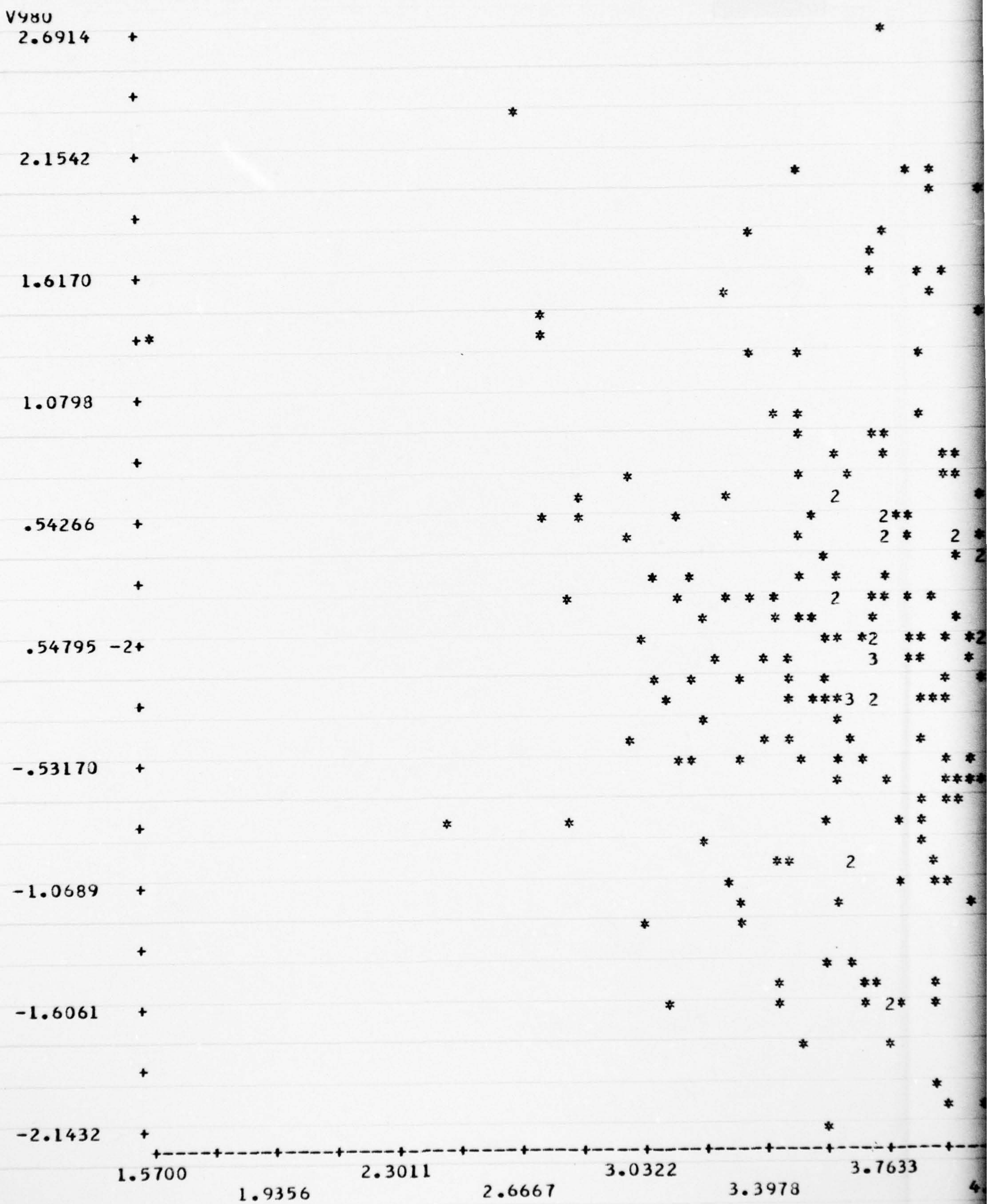

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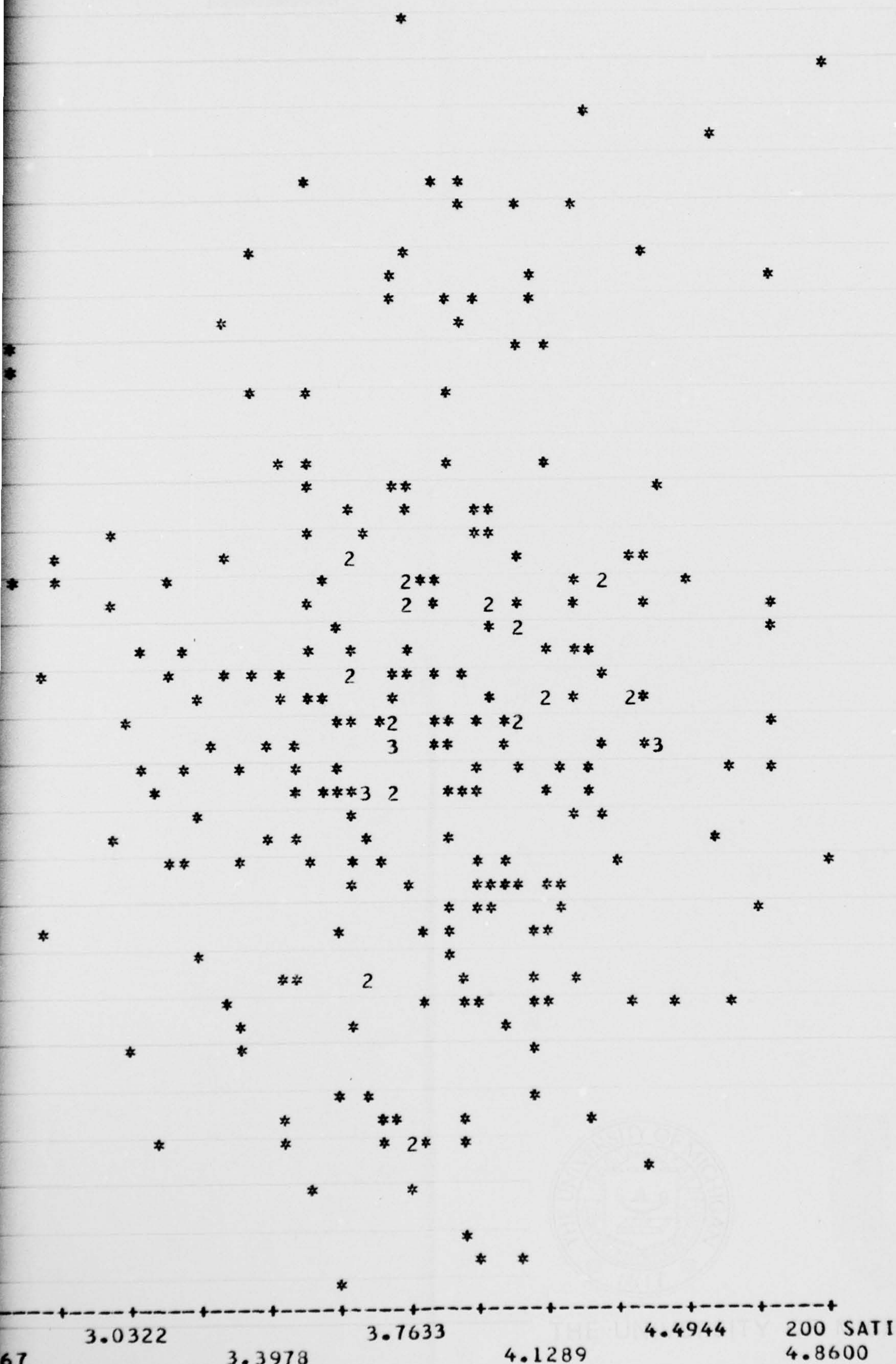

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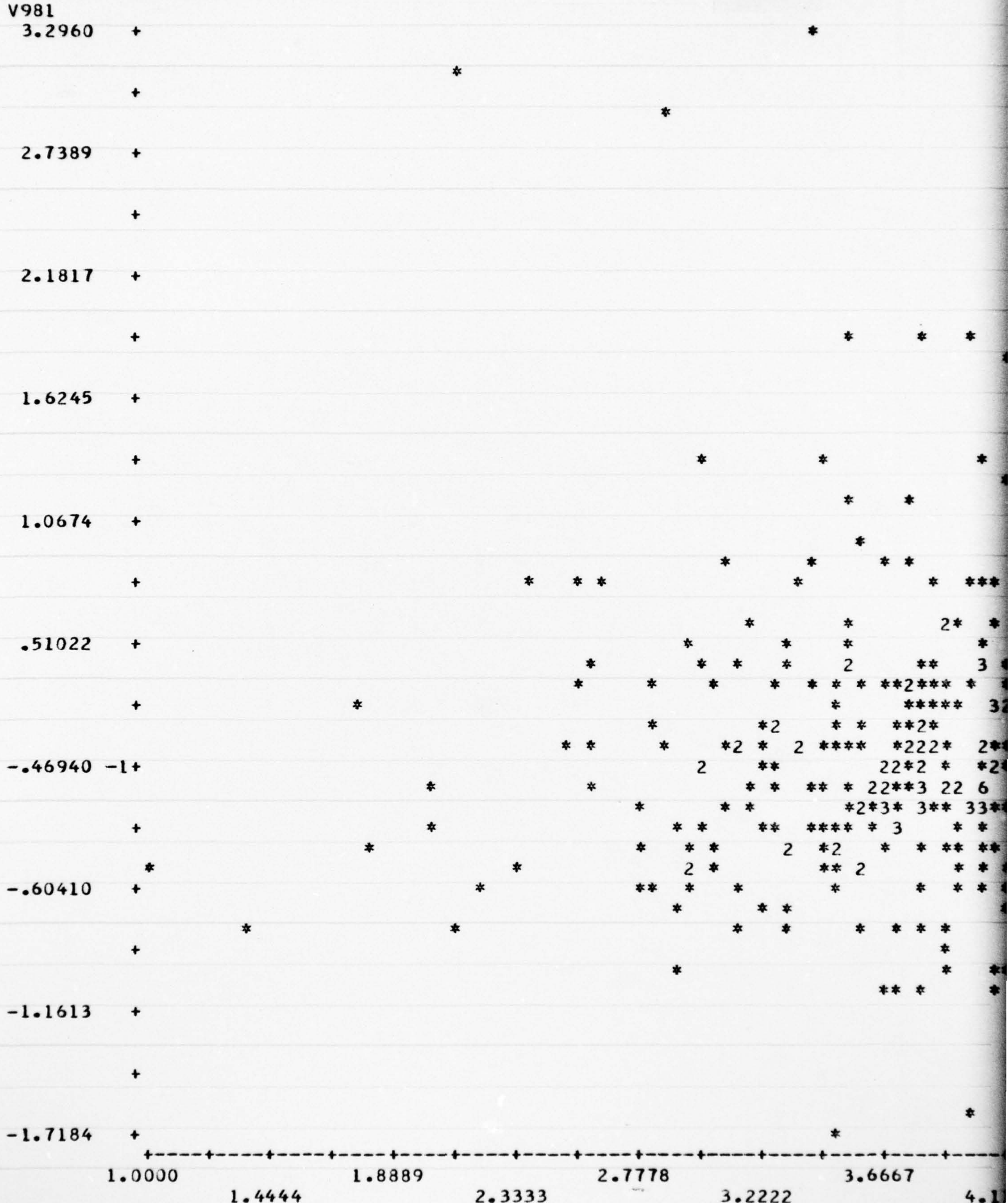

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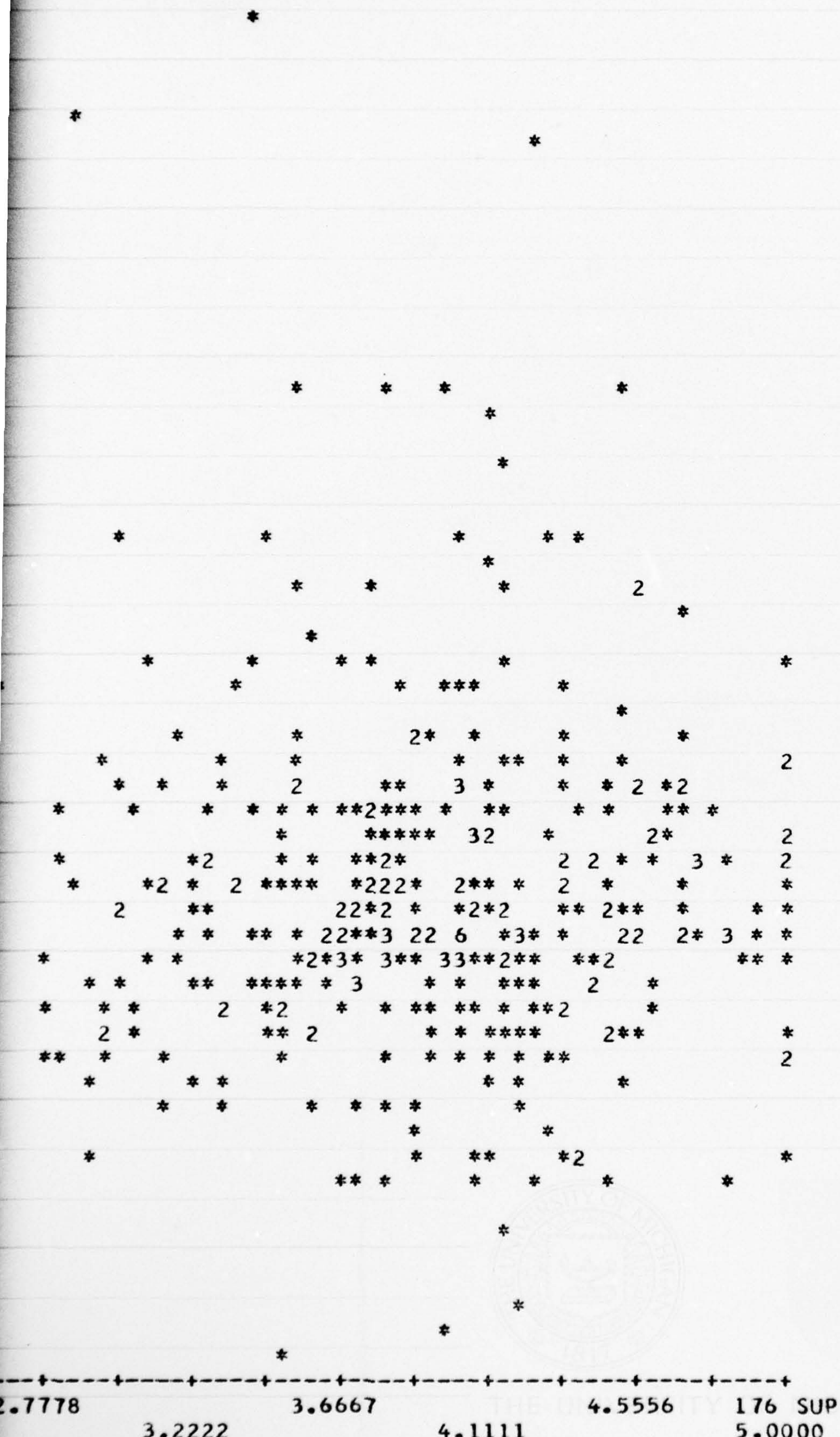

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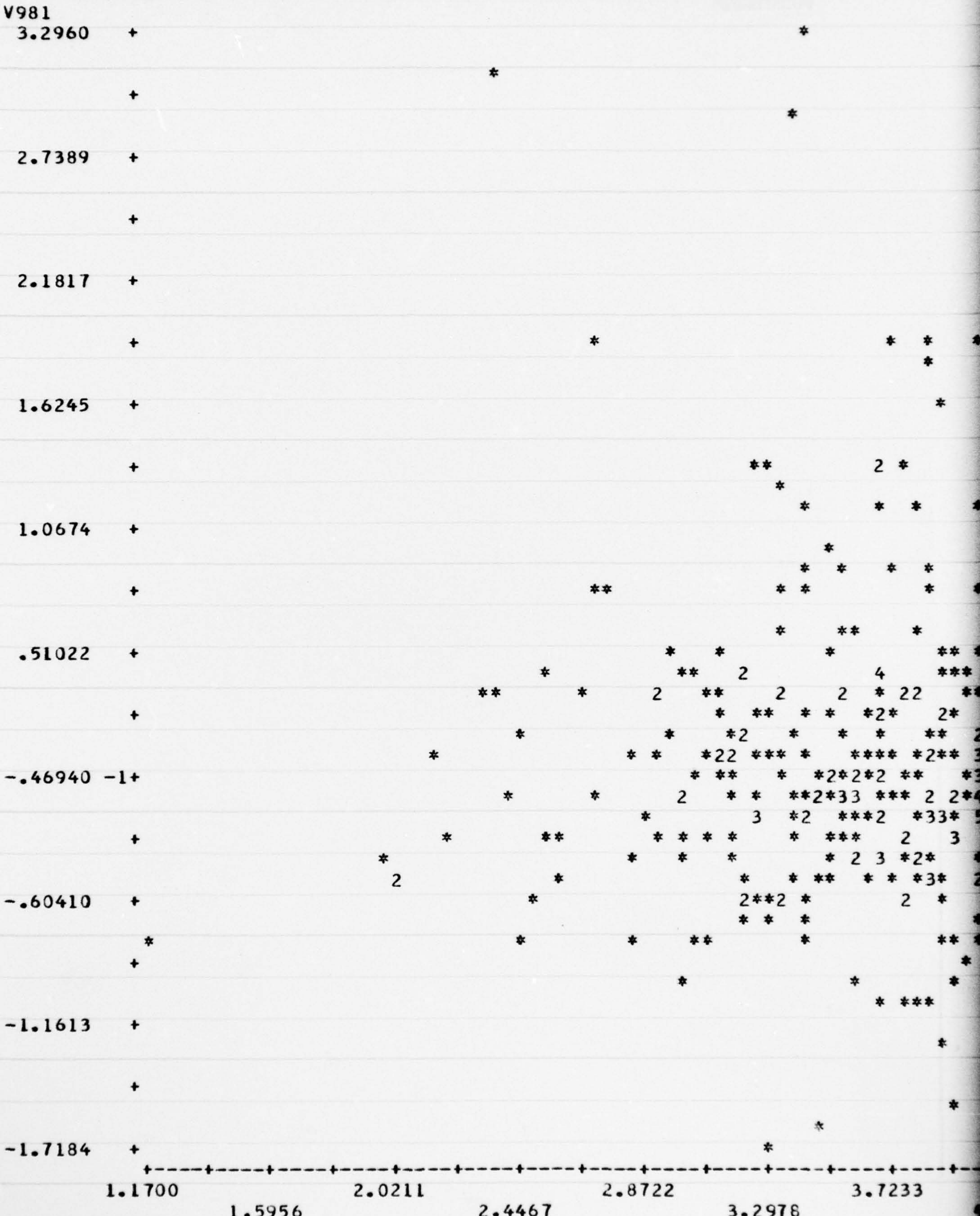

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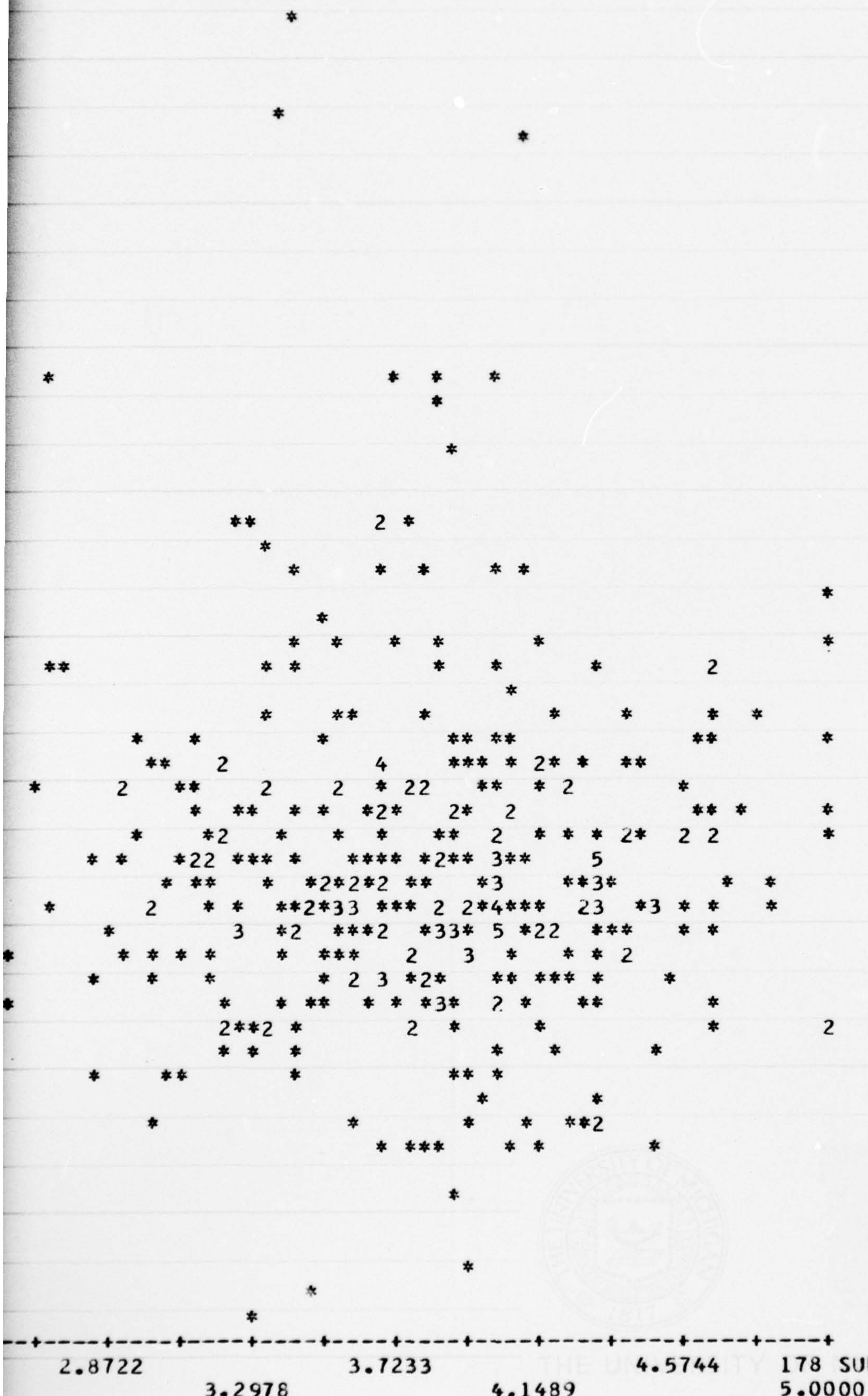

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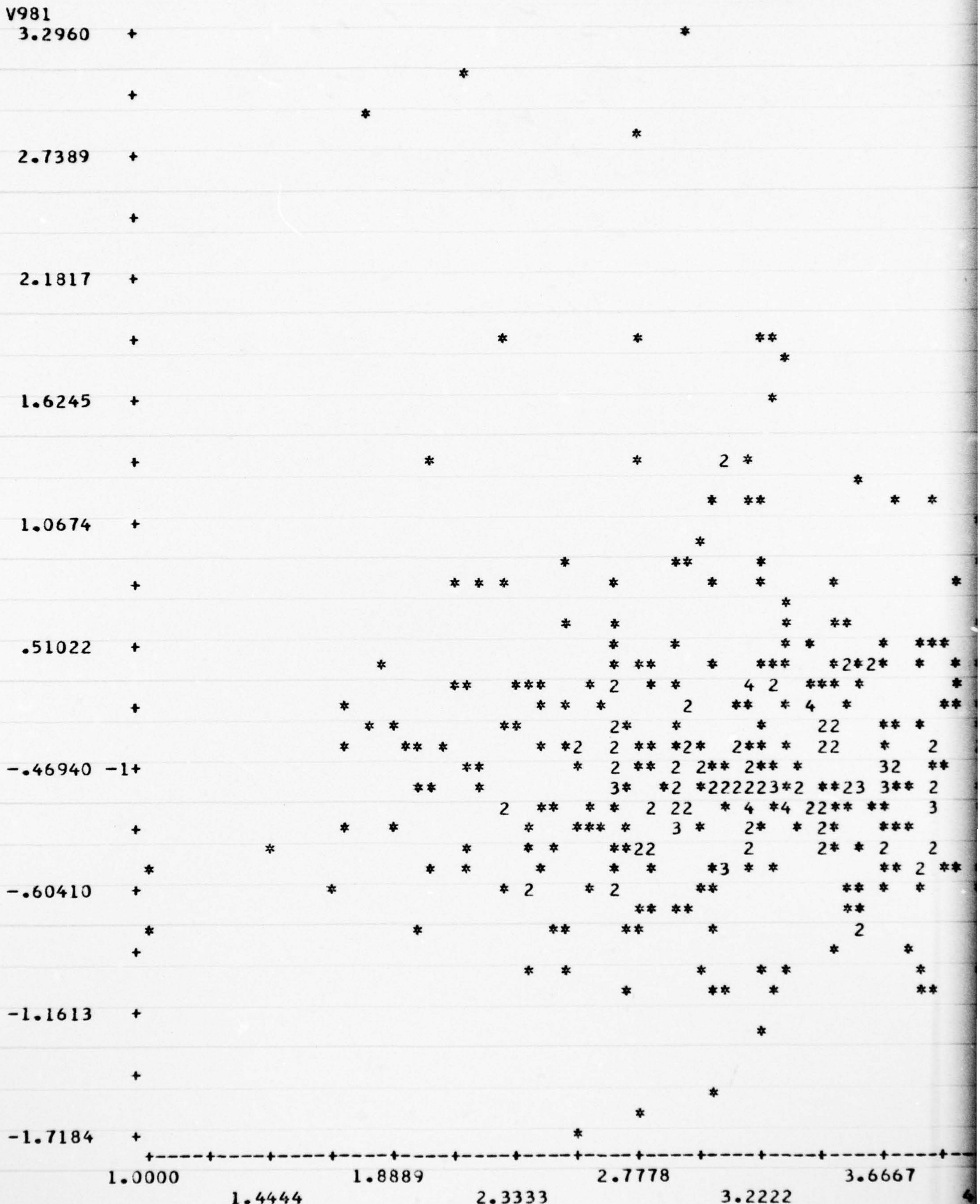

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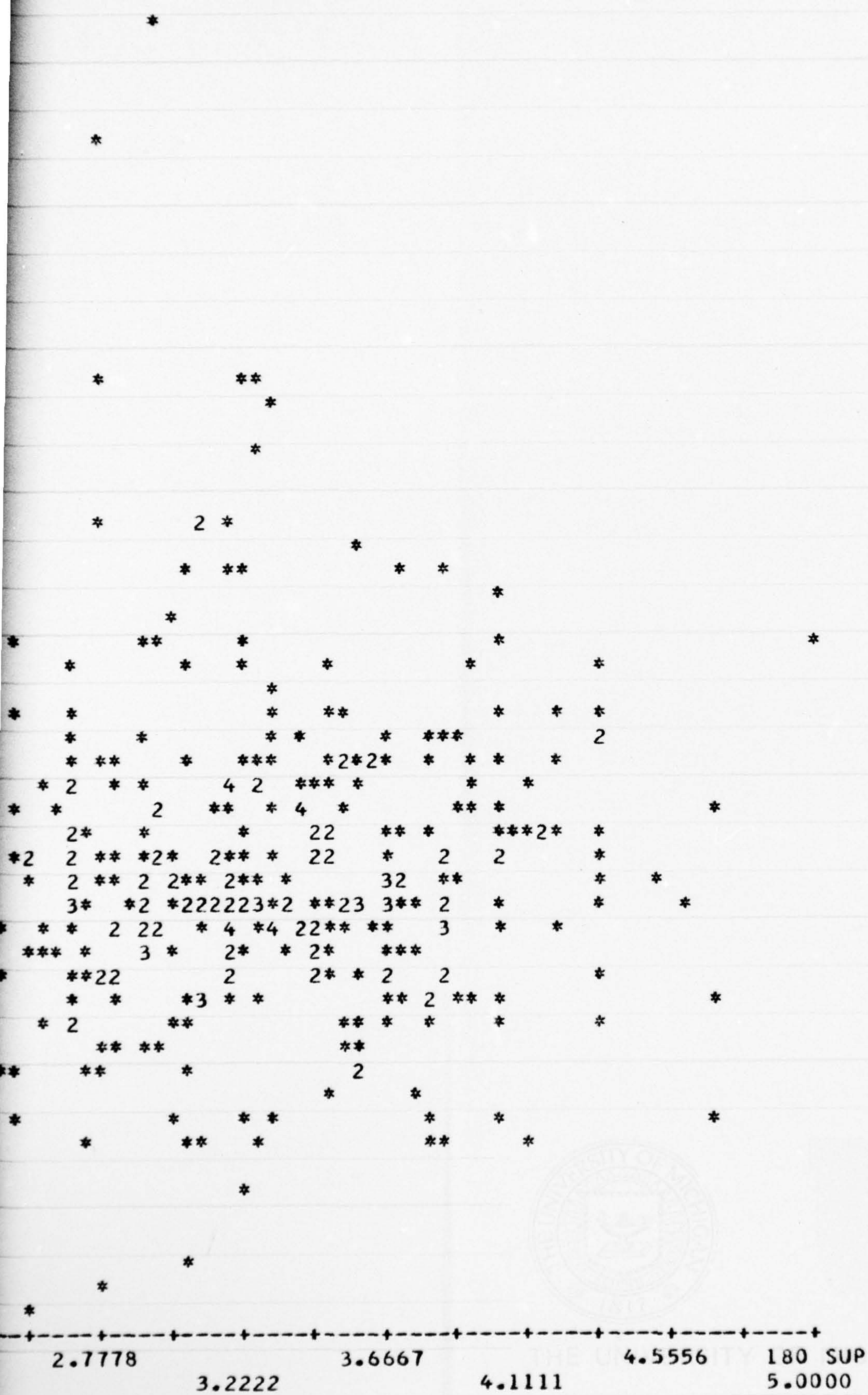

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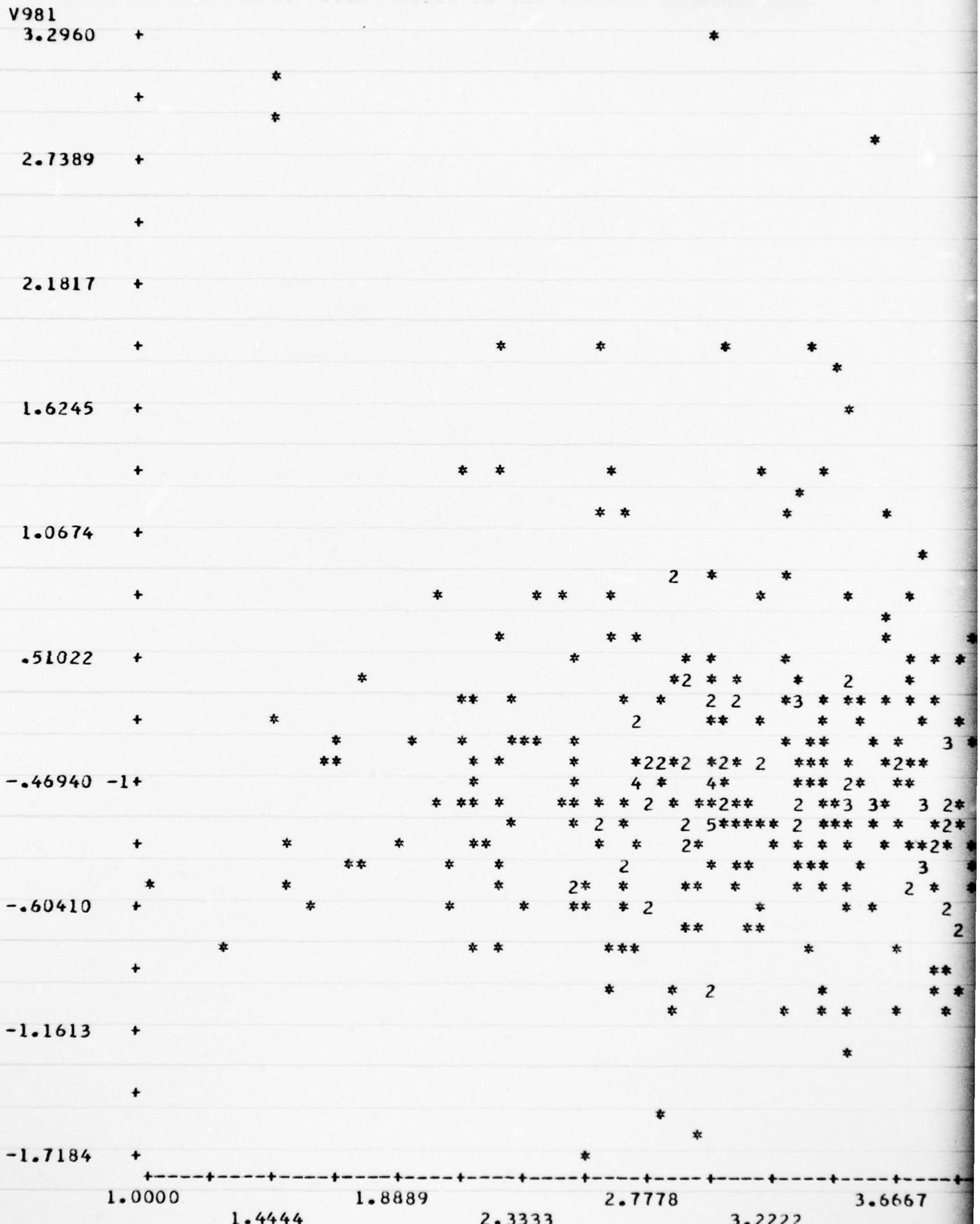

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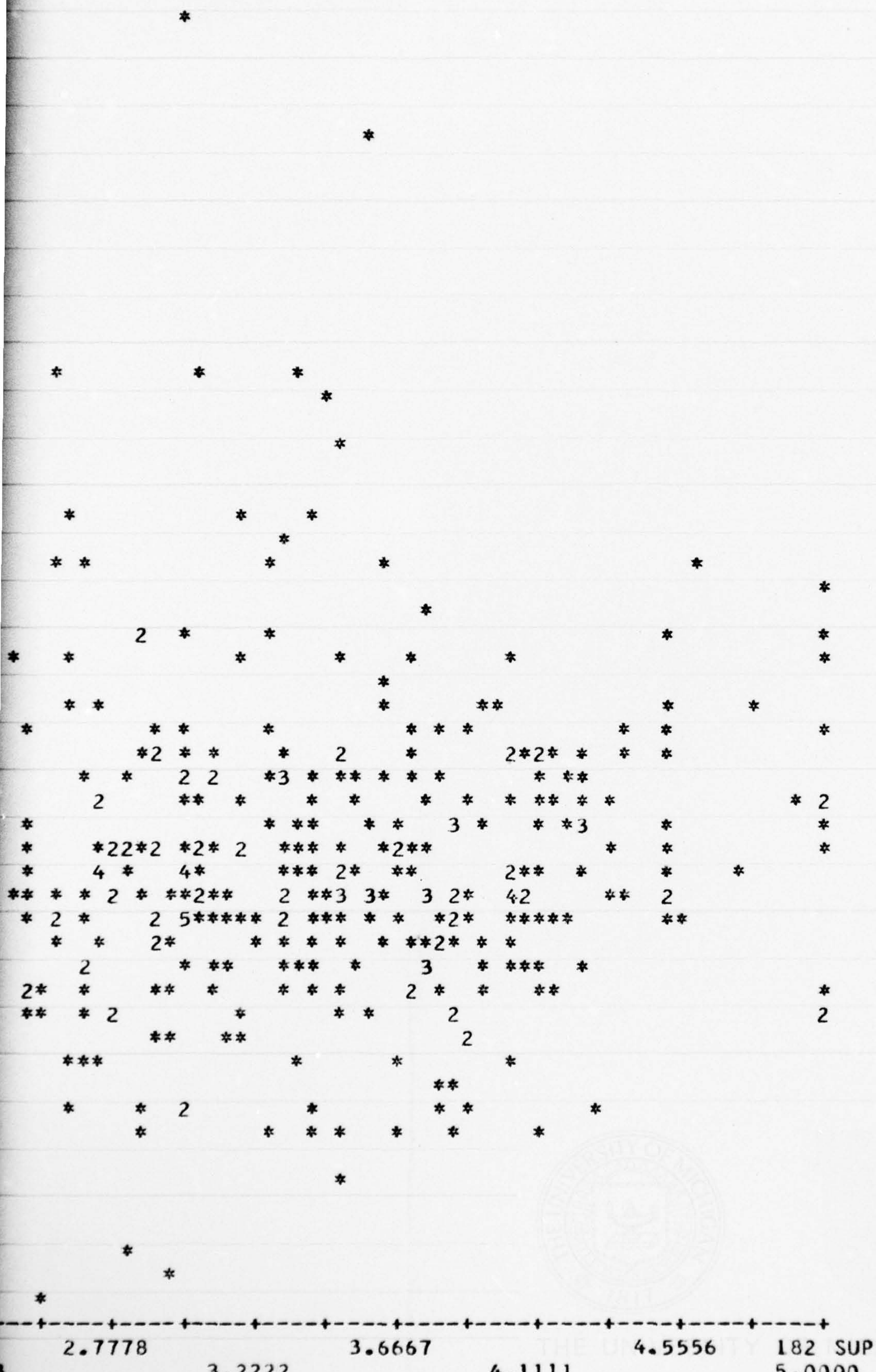

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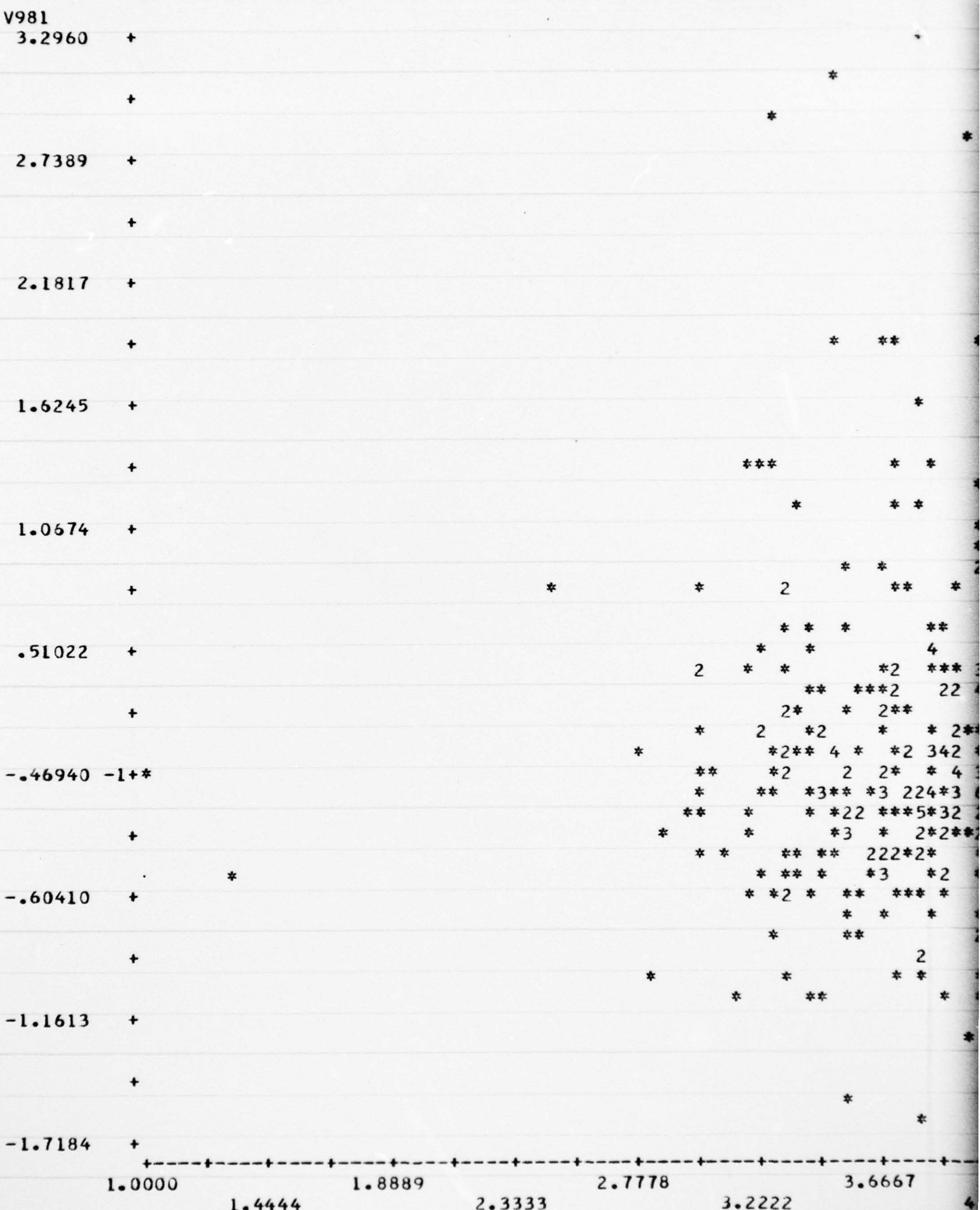

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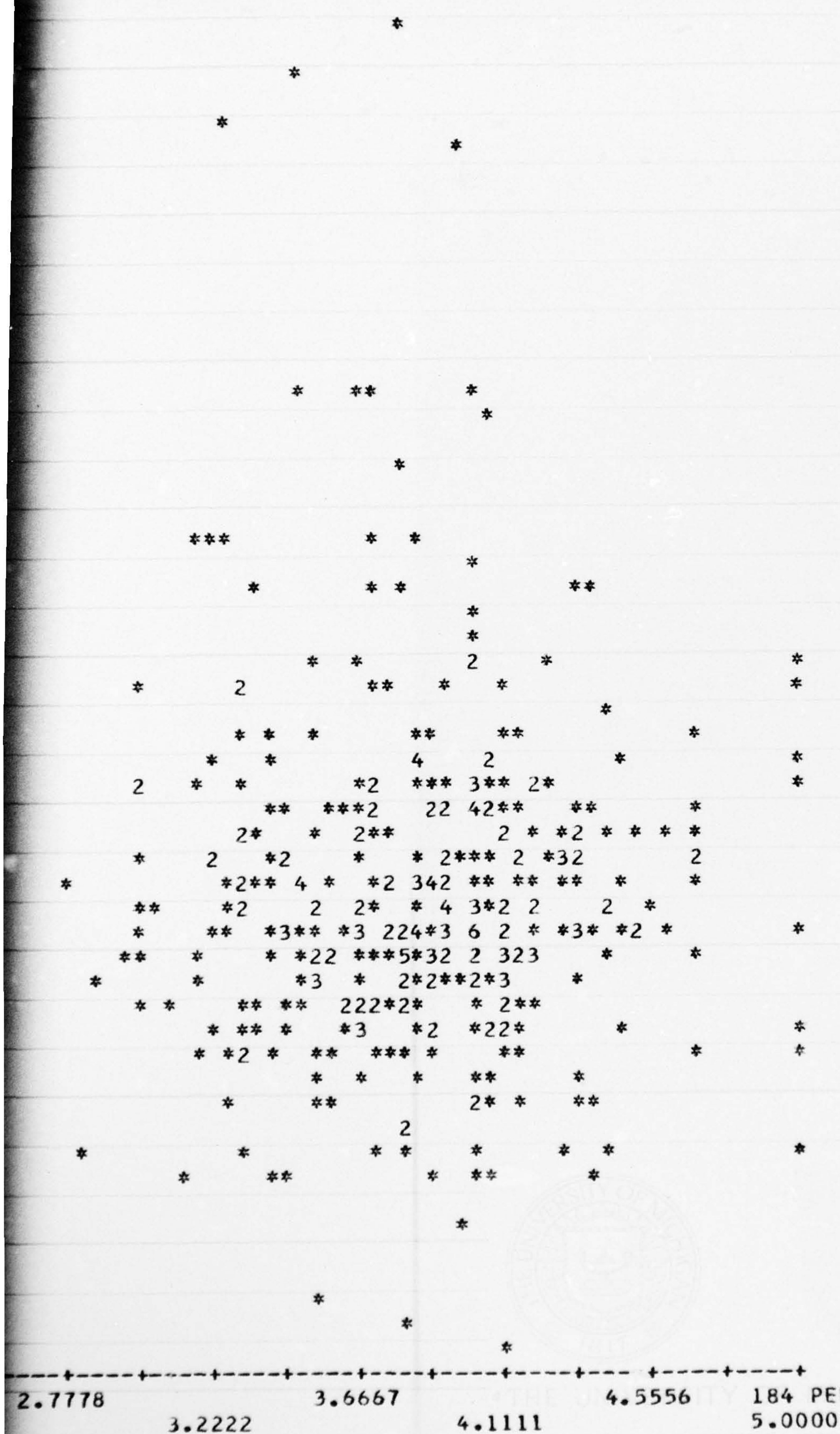

AD-A045 068 MICHIGAN UNIV ANN ARBOR INST FOR SOCIAL RESEARCH F/G 5/9
FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH T--ETC(U)
JUN 77 A S DAVENPORT, J B LAPOINTE N00014-76-C-0362

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5 OF 7
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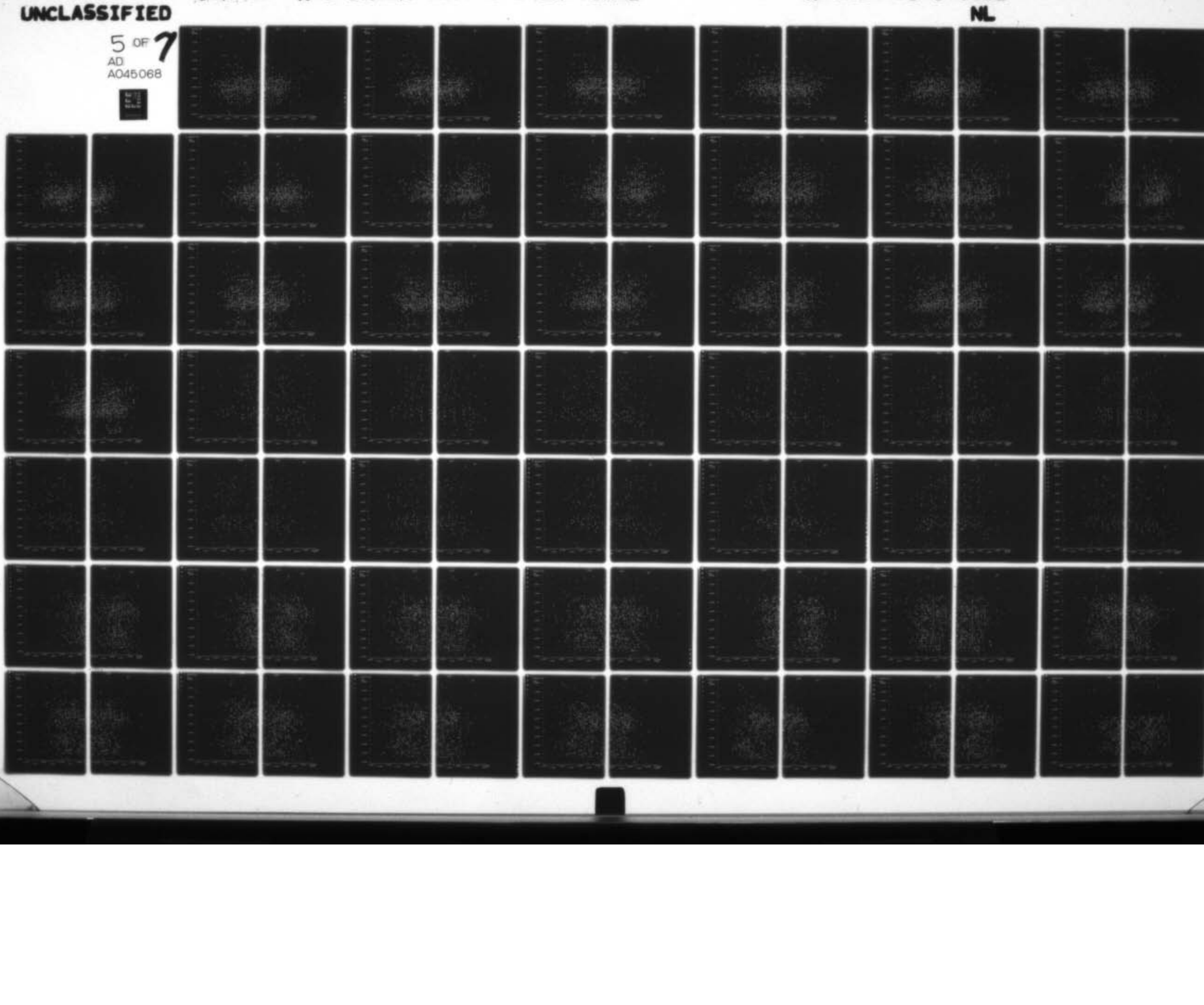

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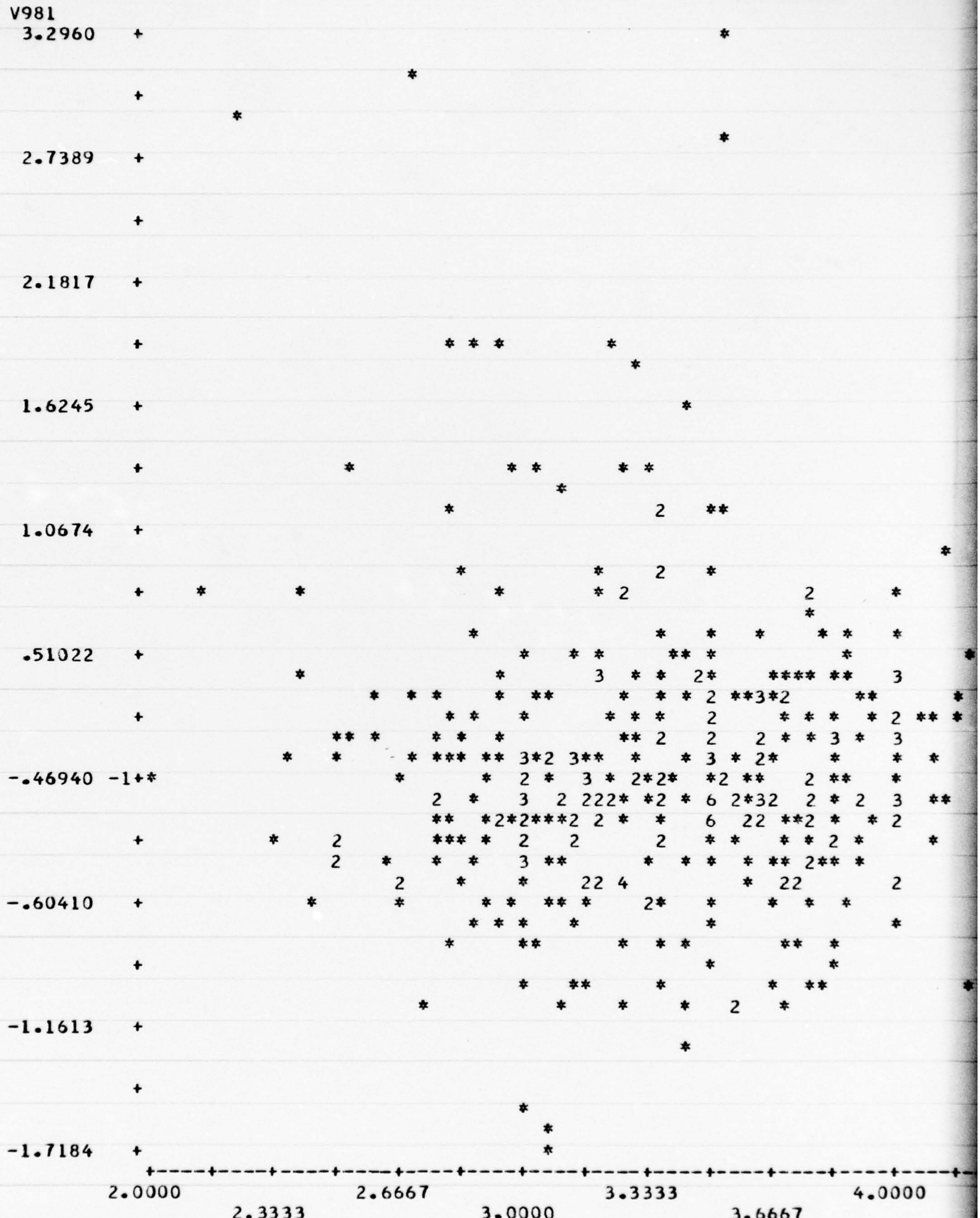

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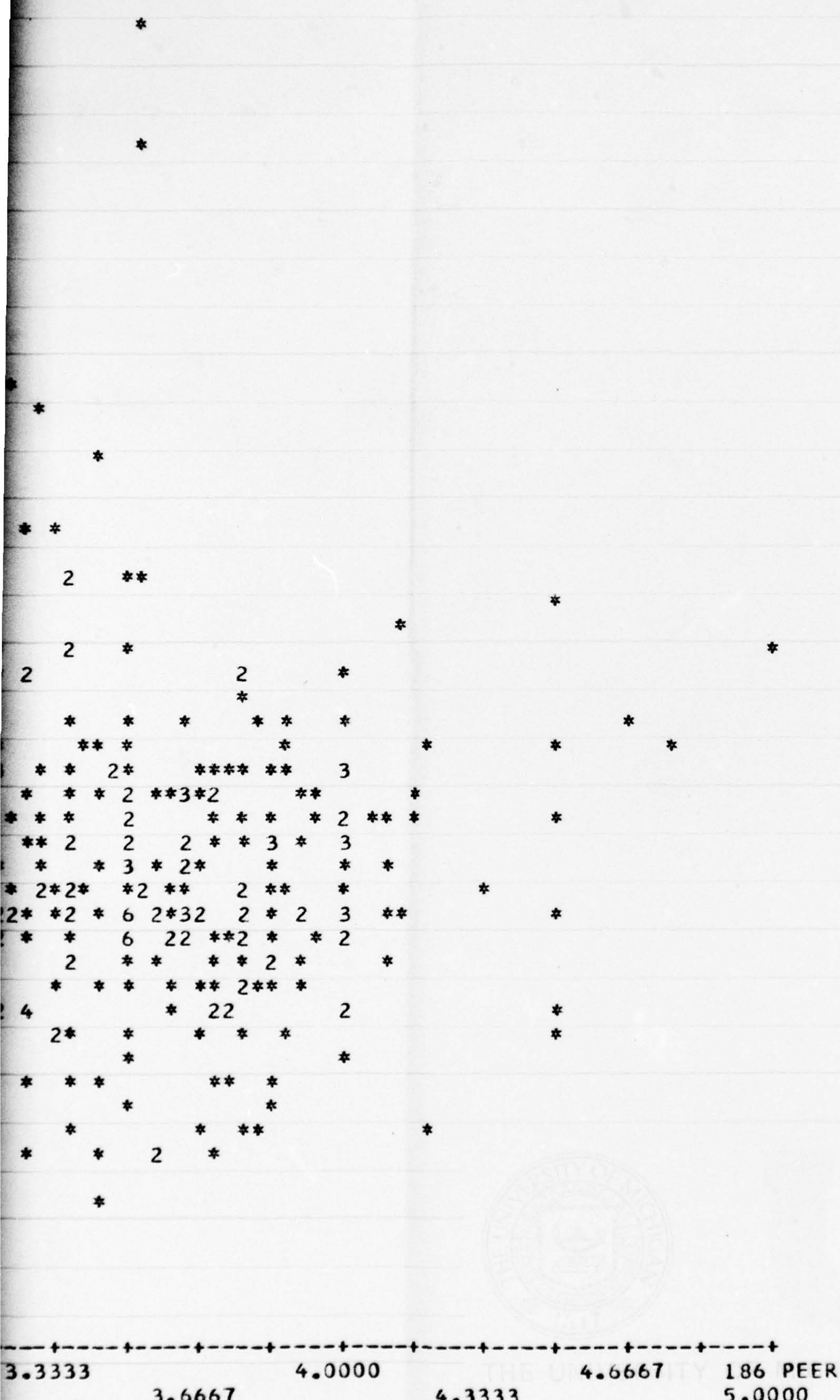

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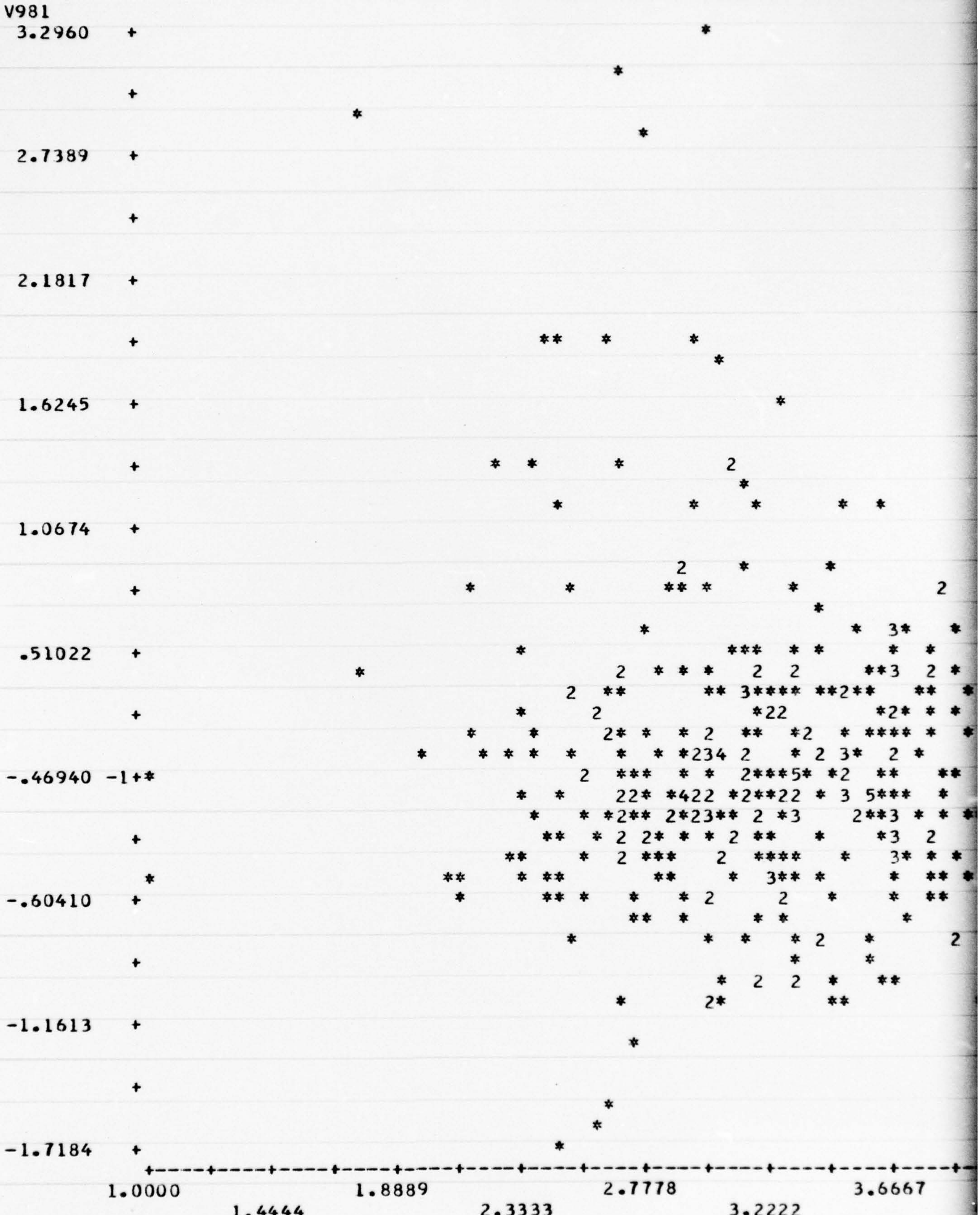

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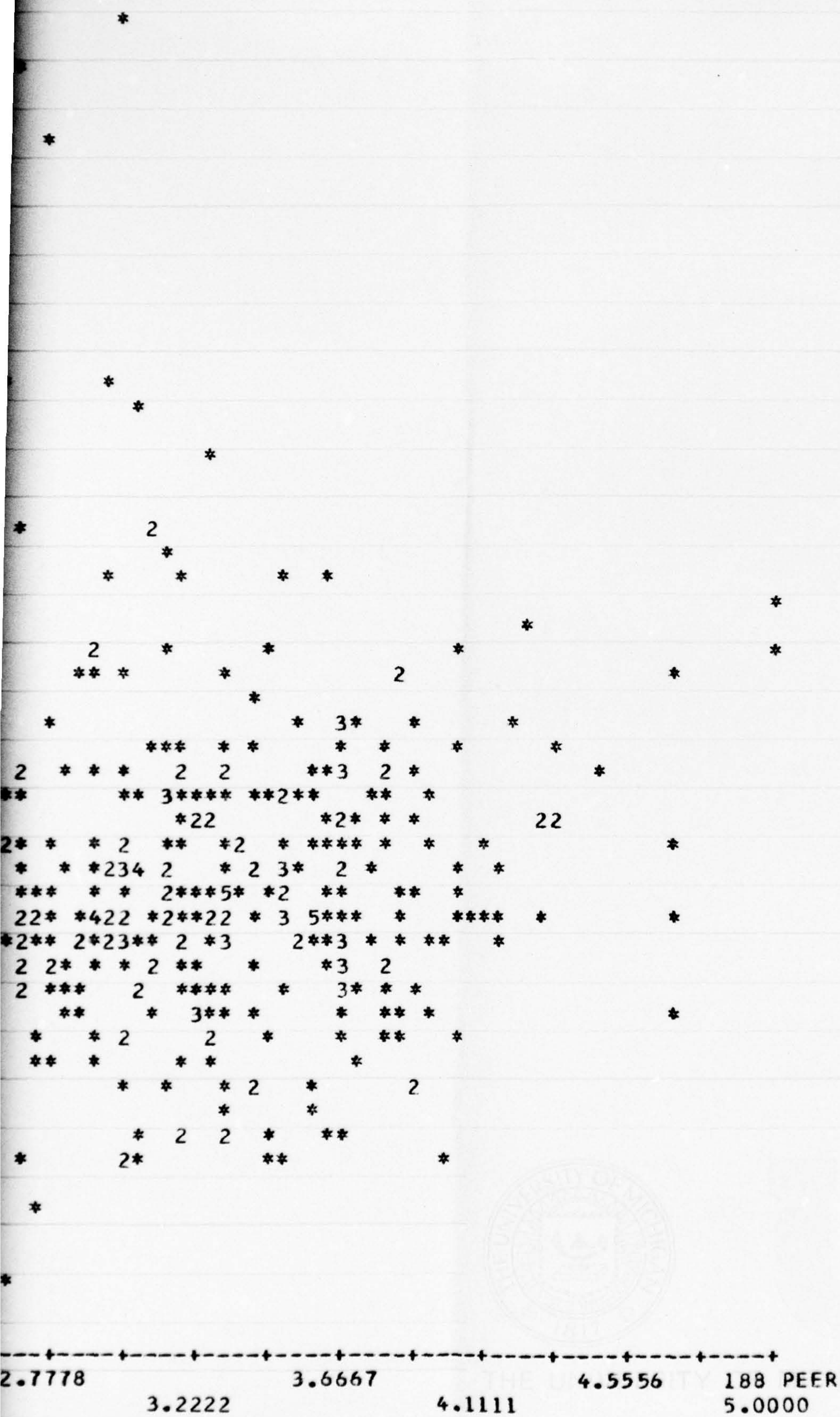

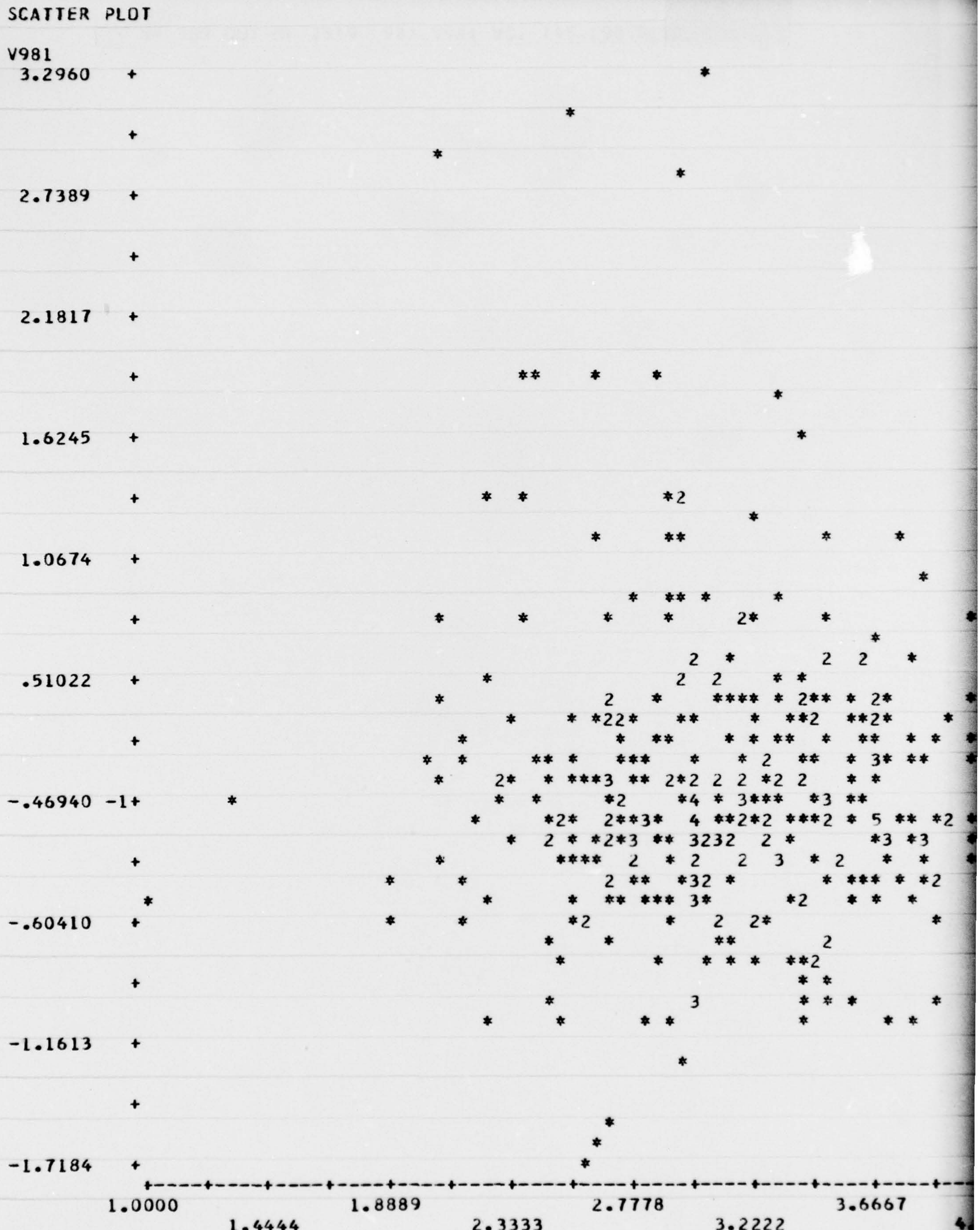
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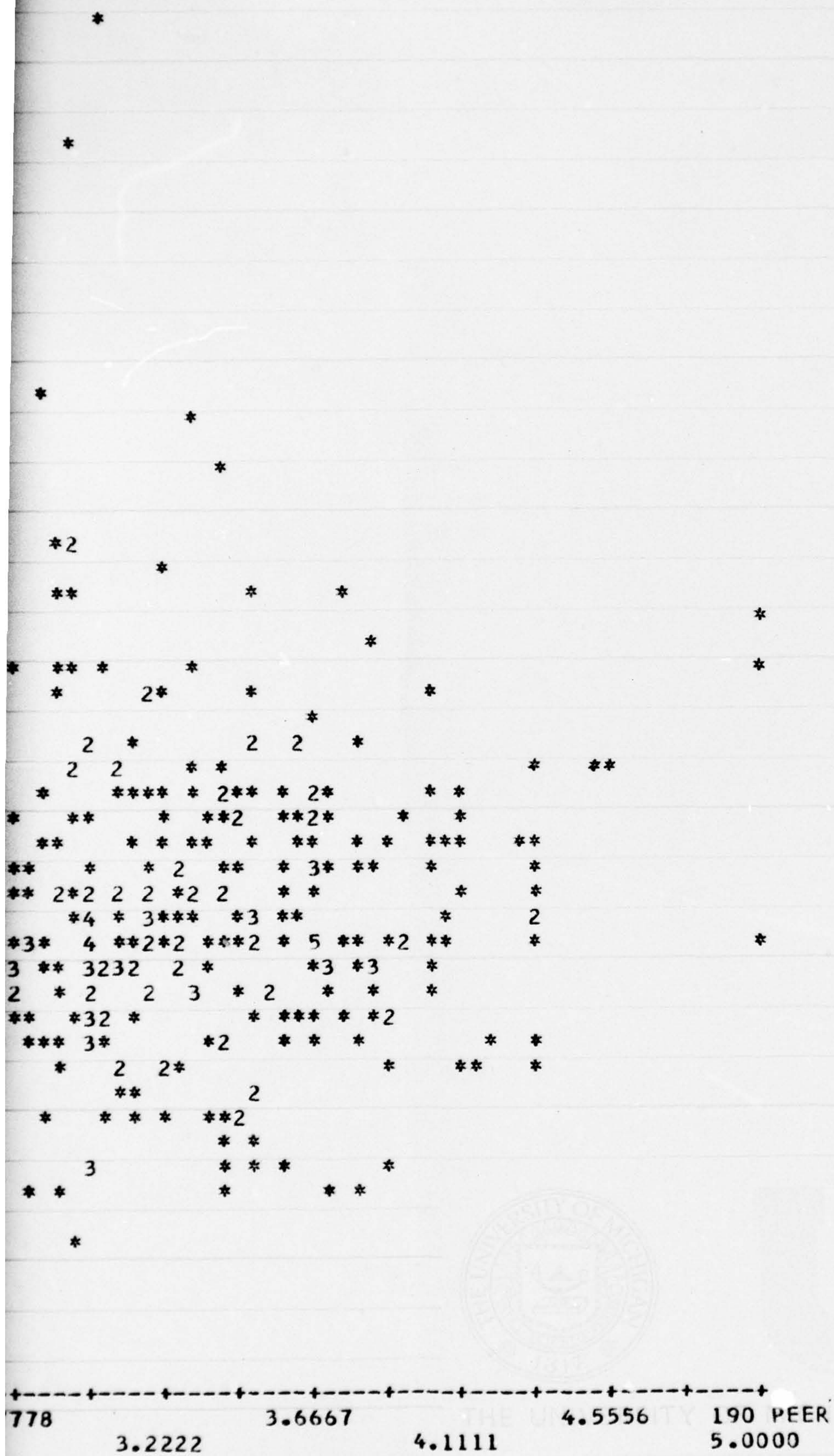

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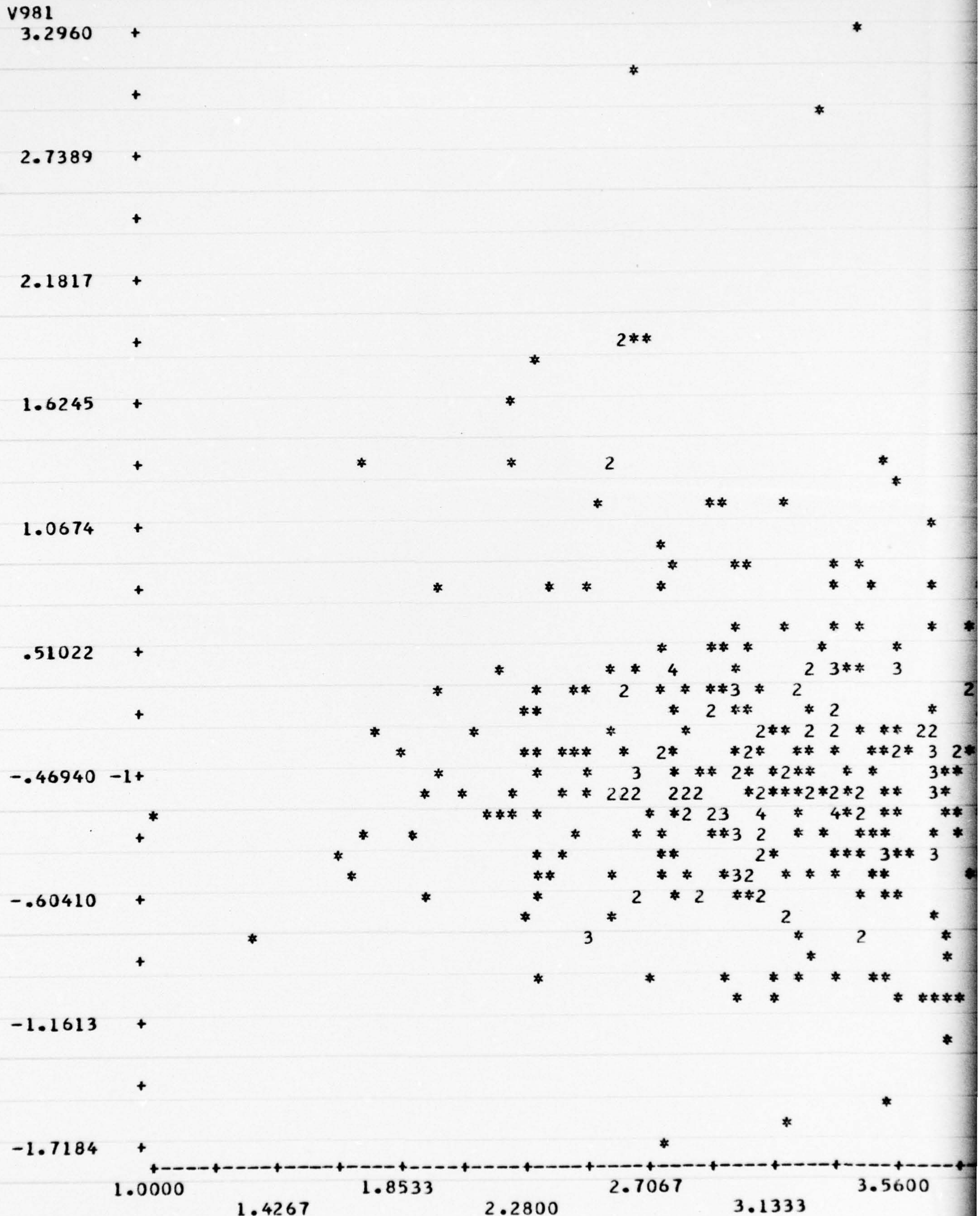

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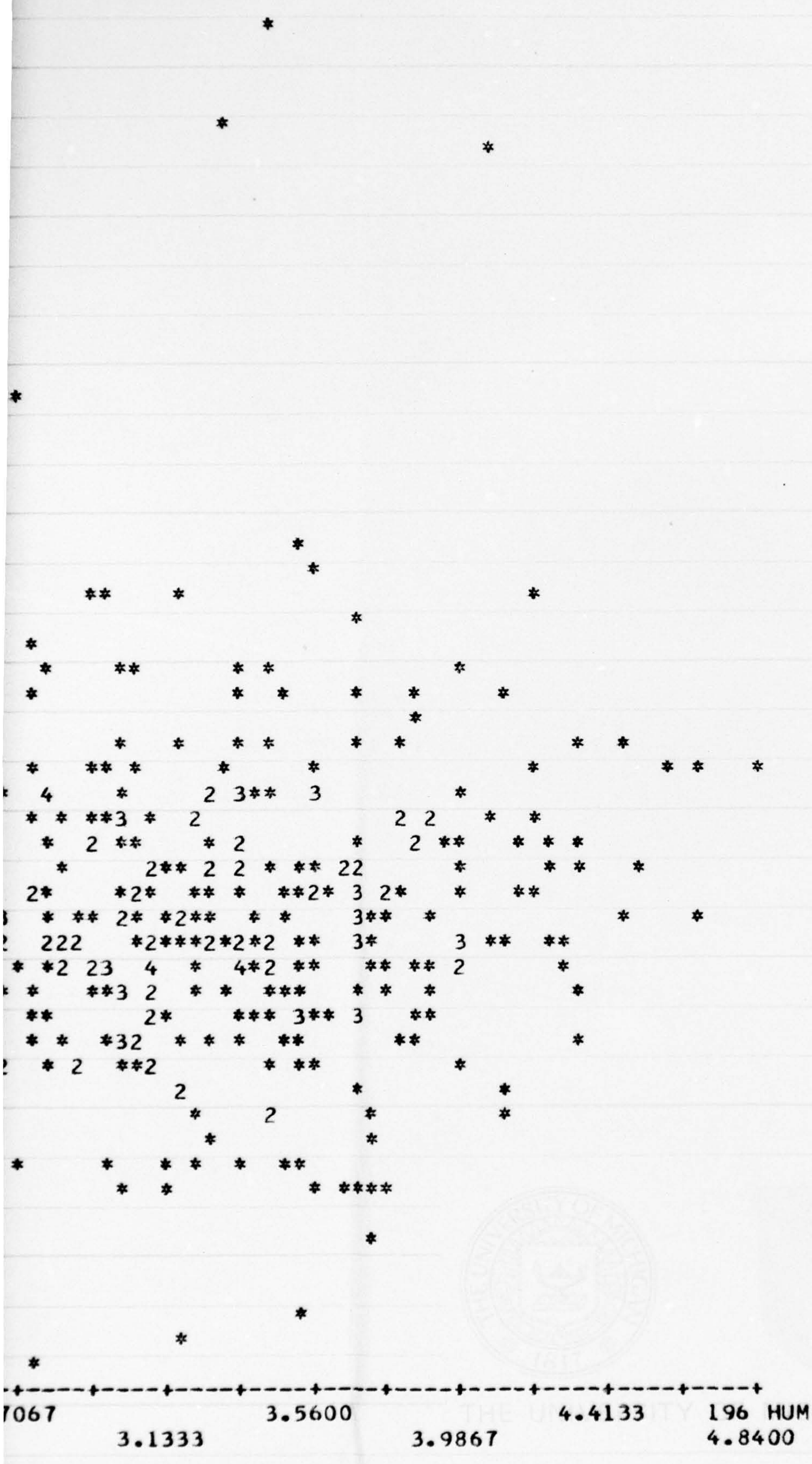

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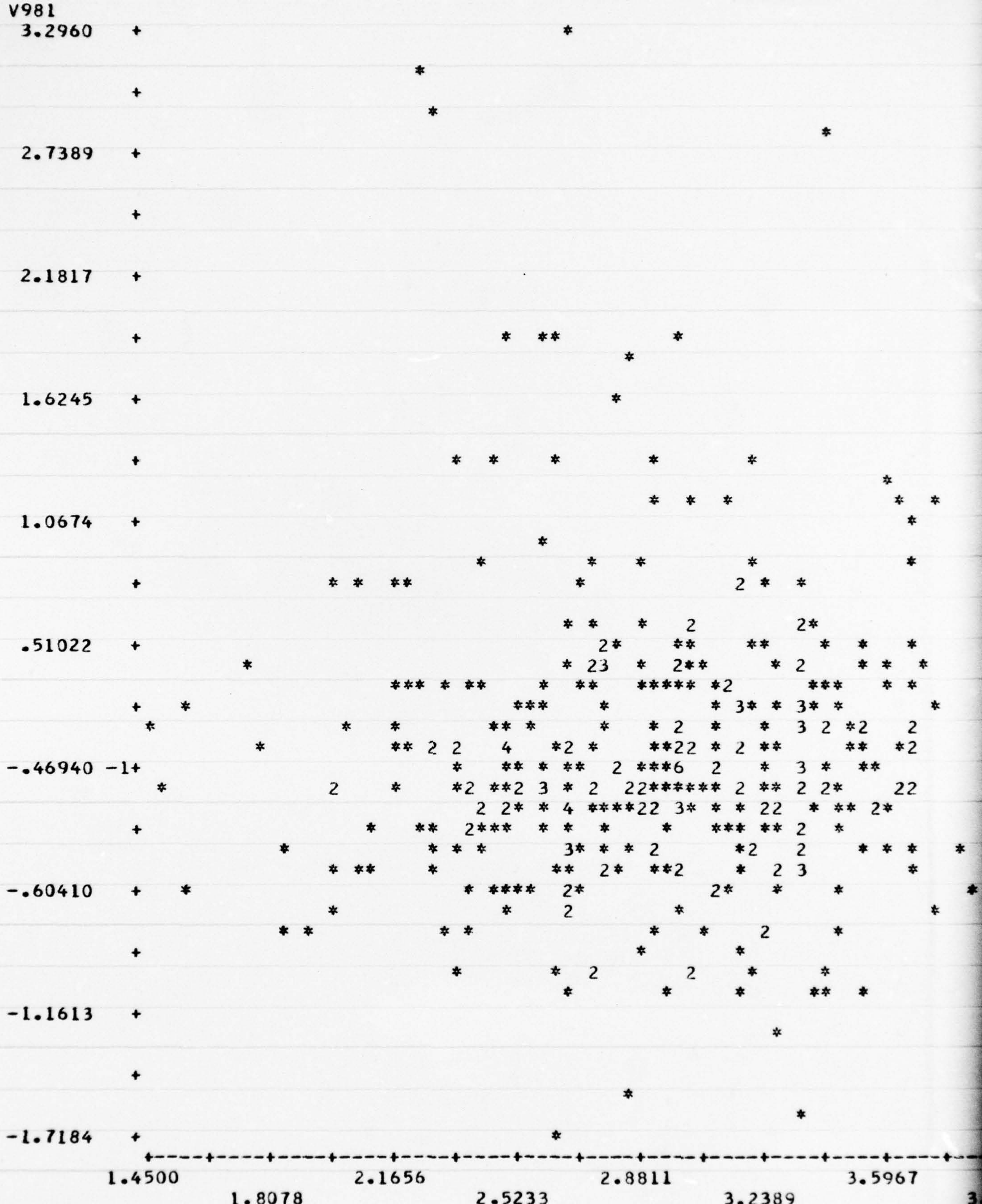

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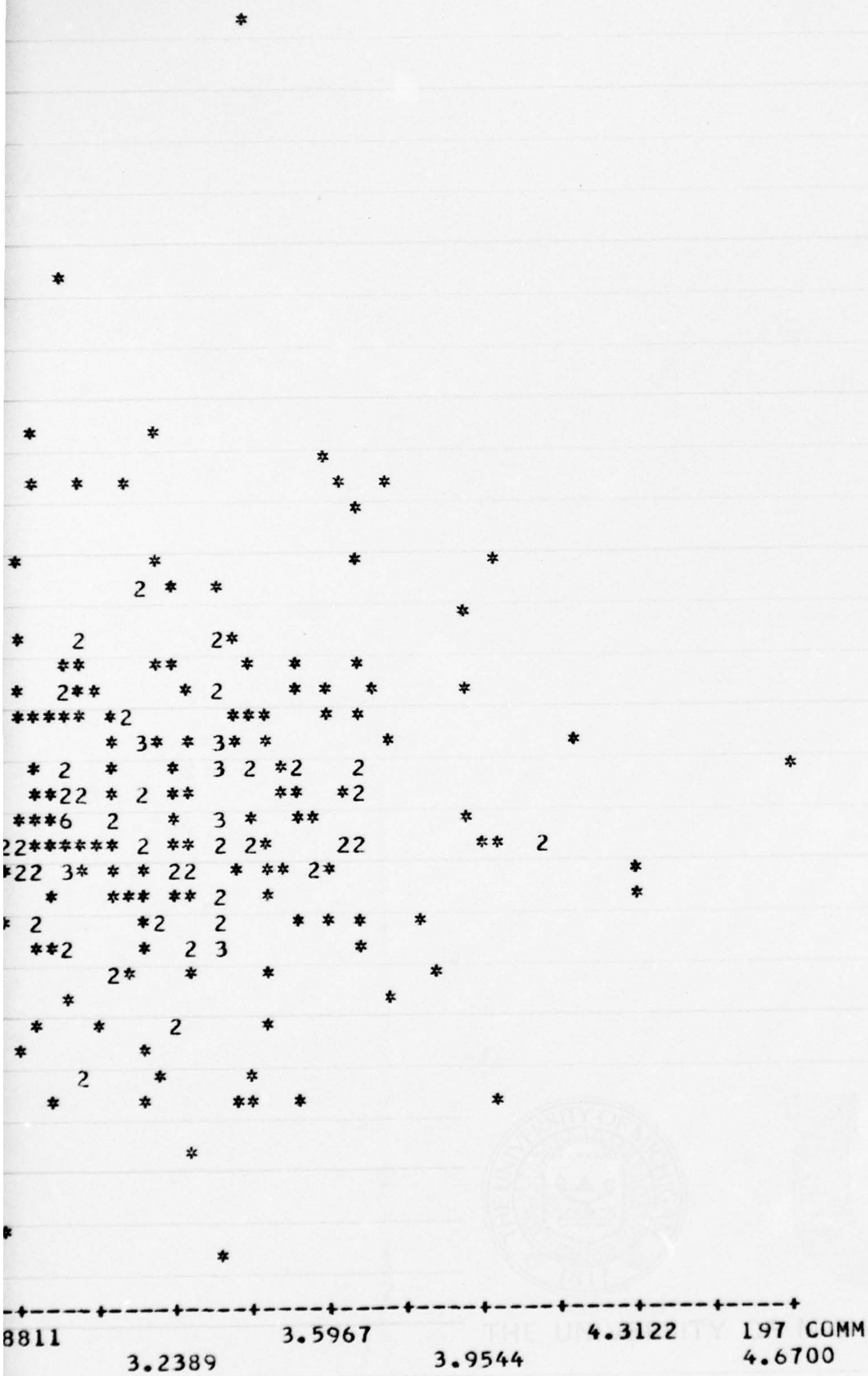

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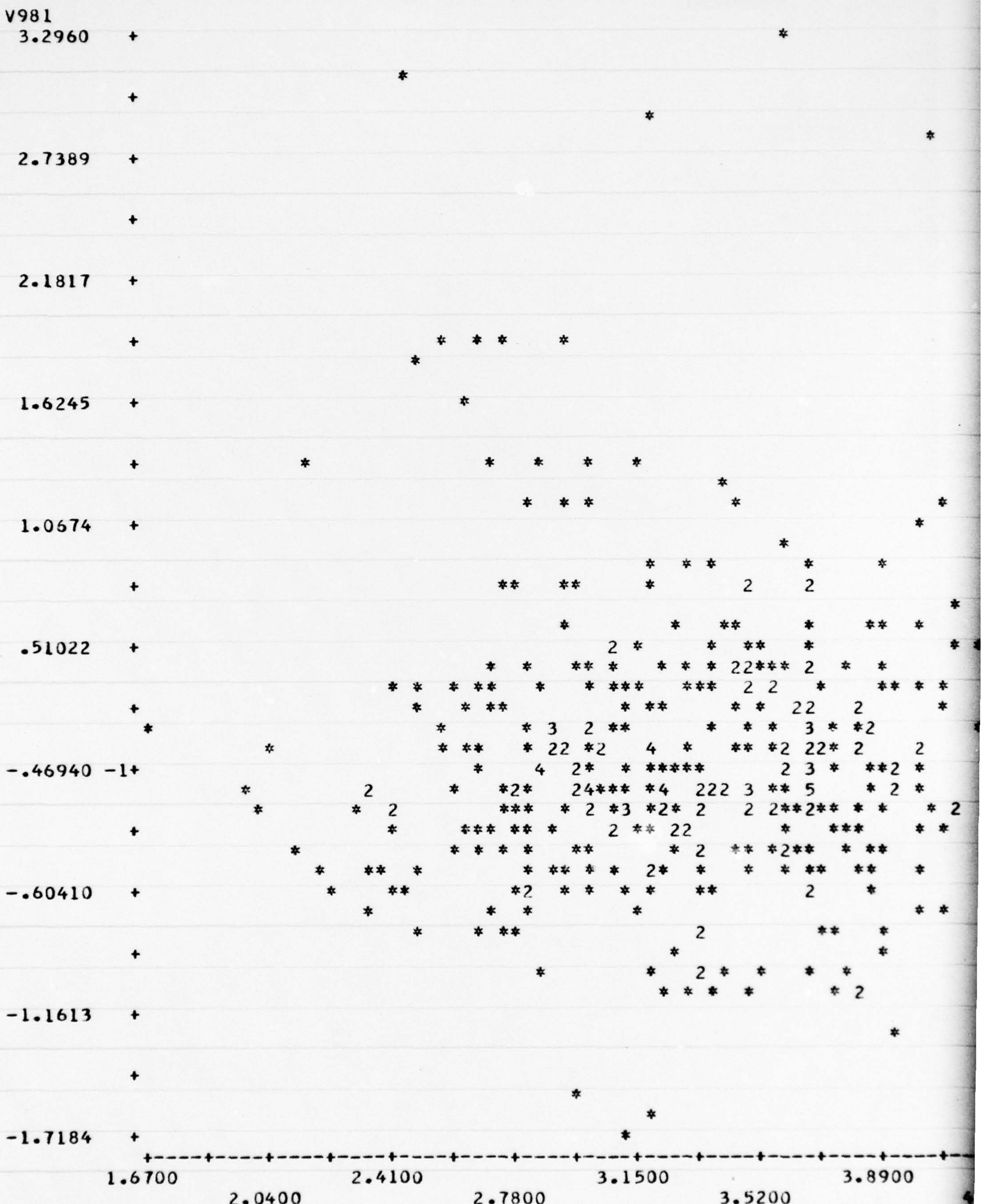

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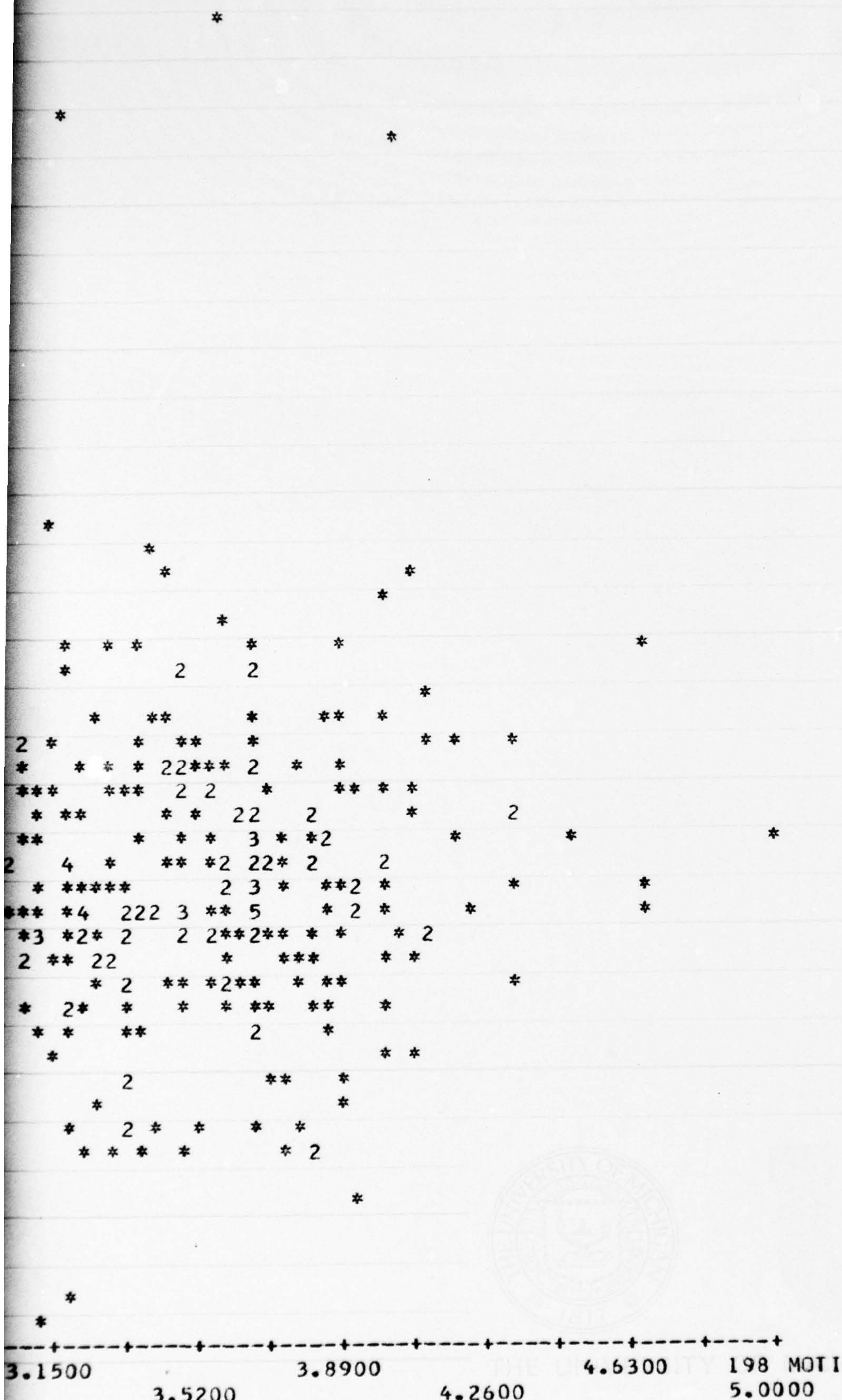

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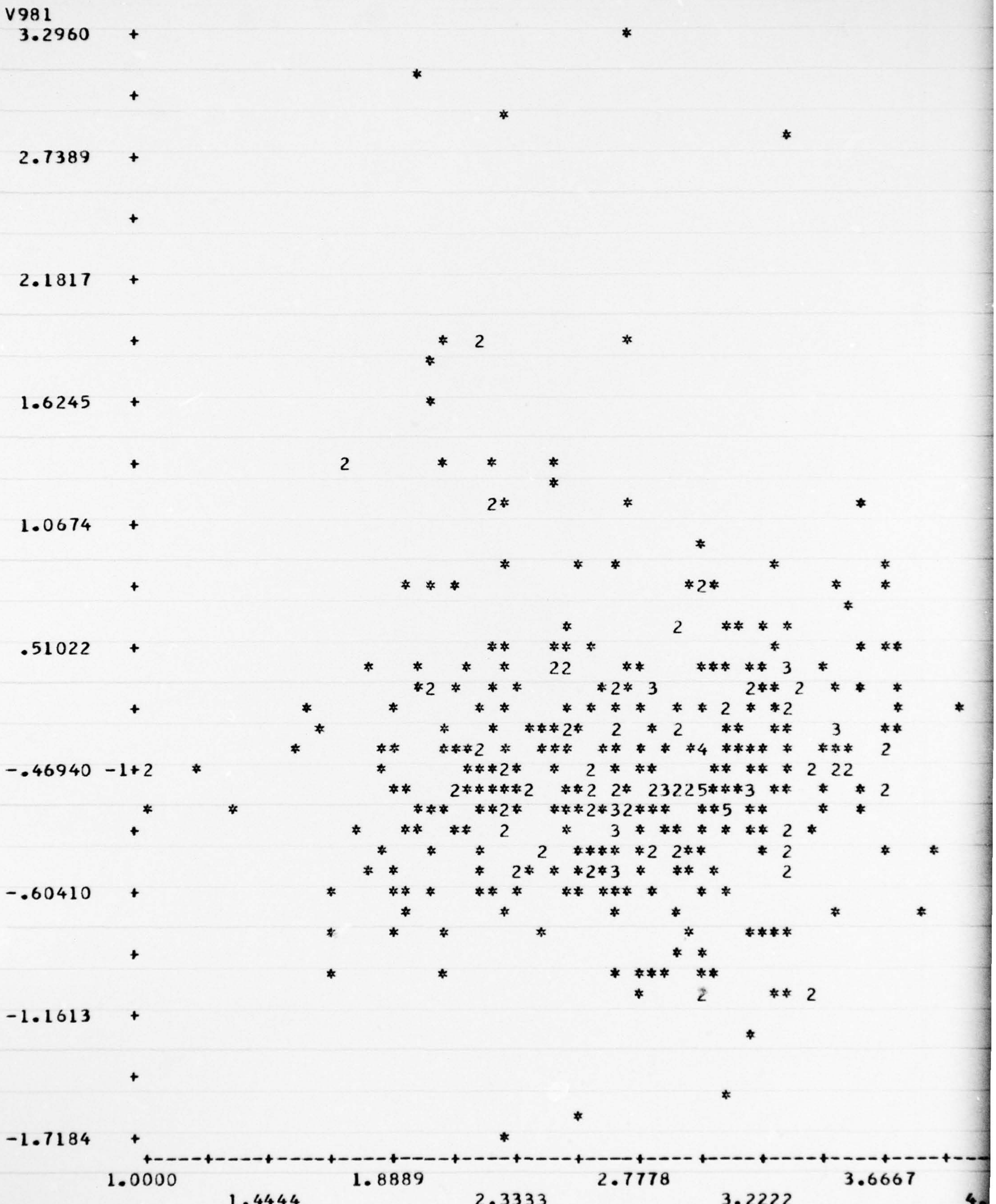

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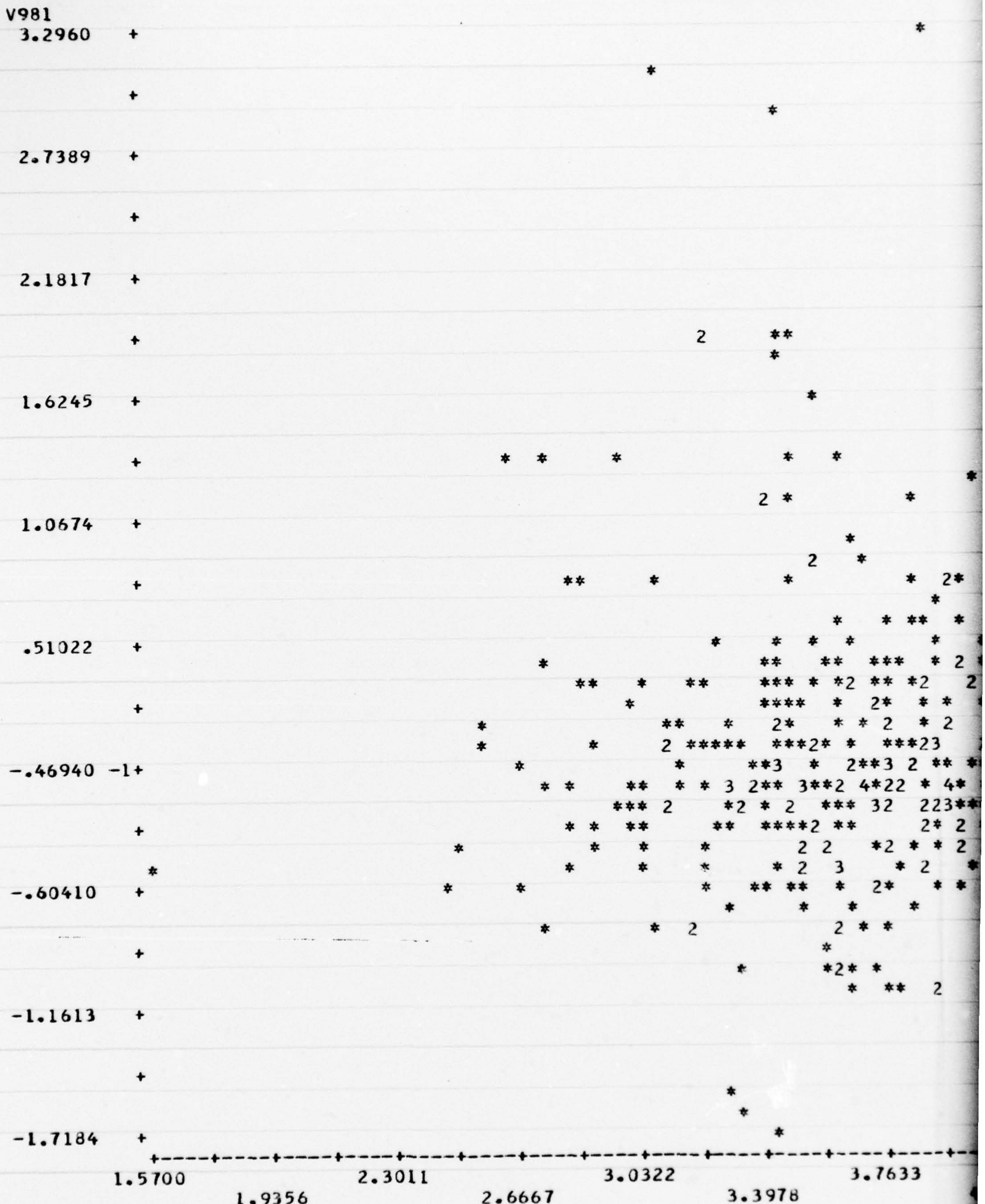

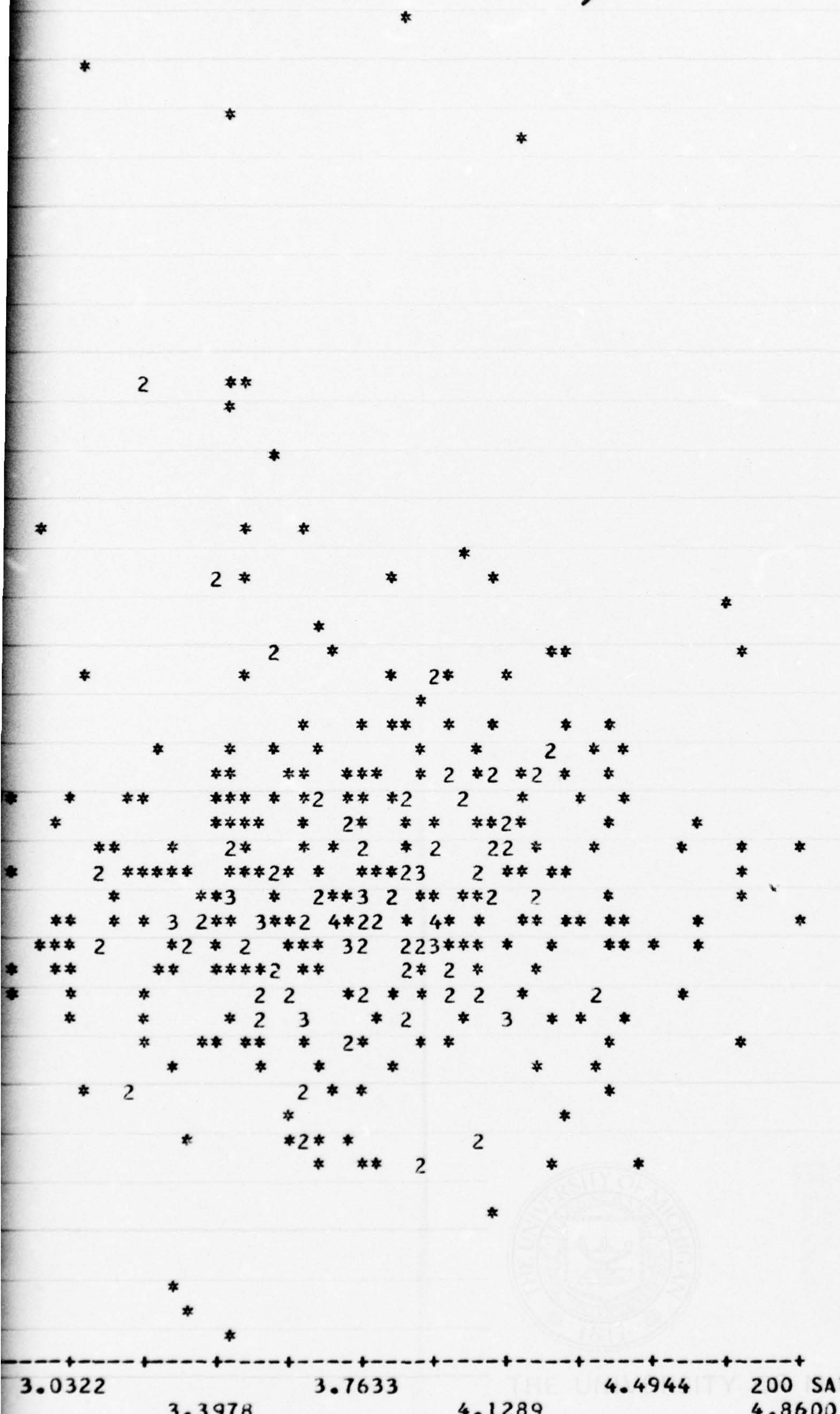
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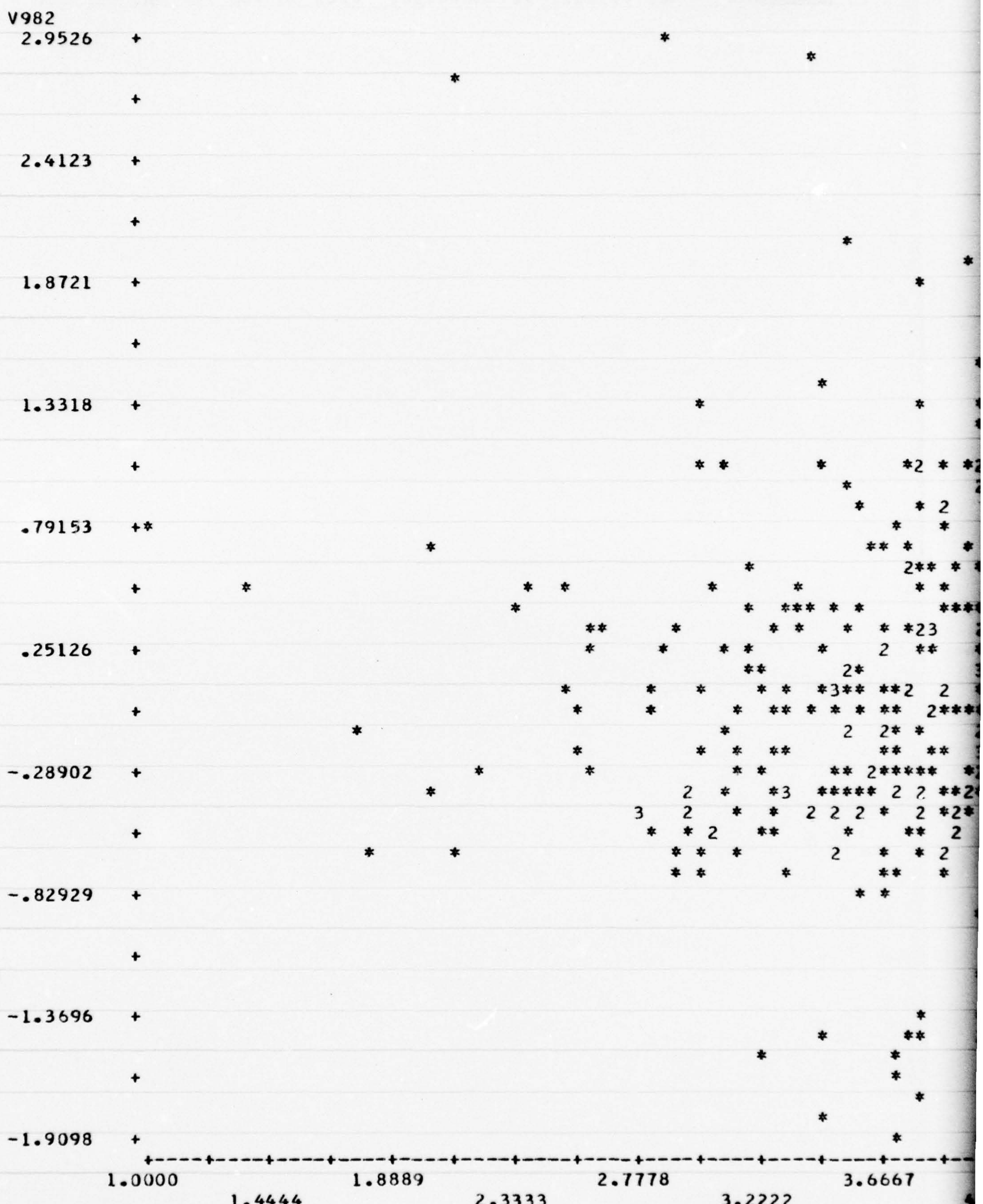

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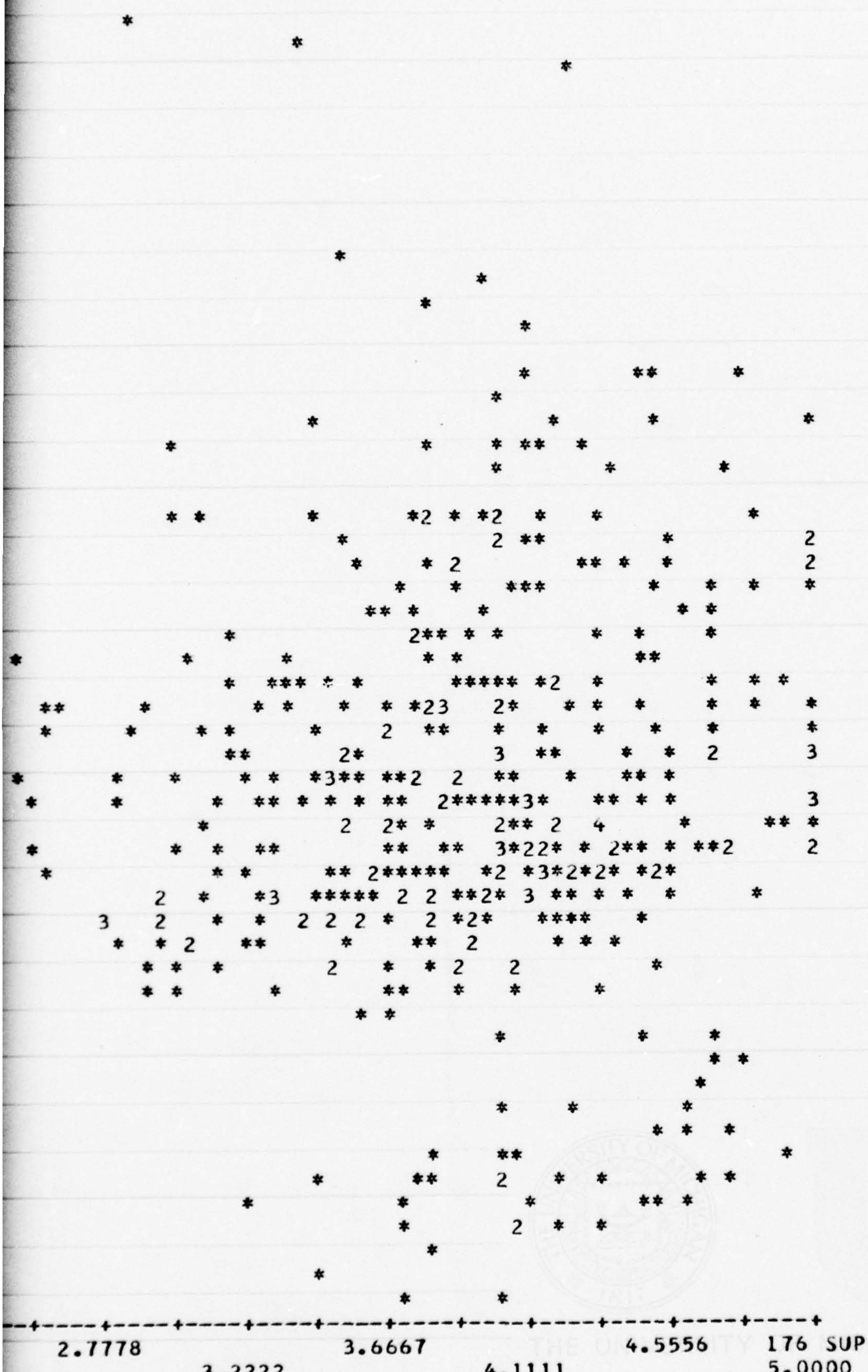

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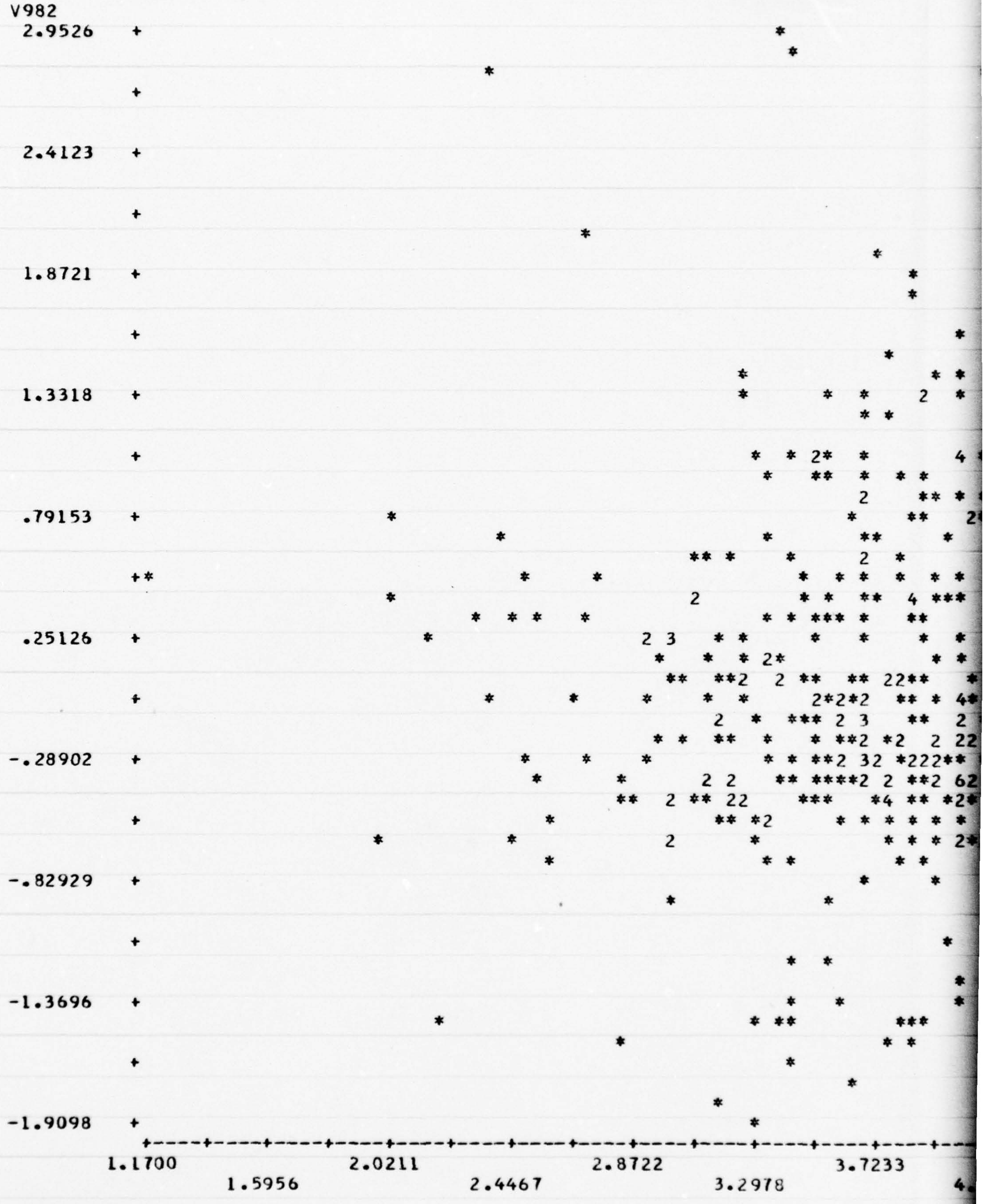

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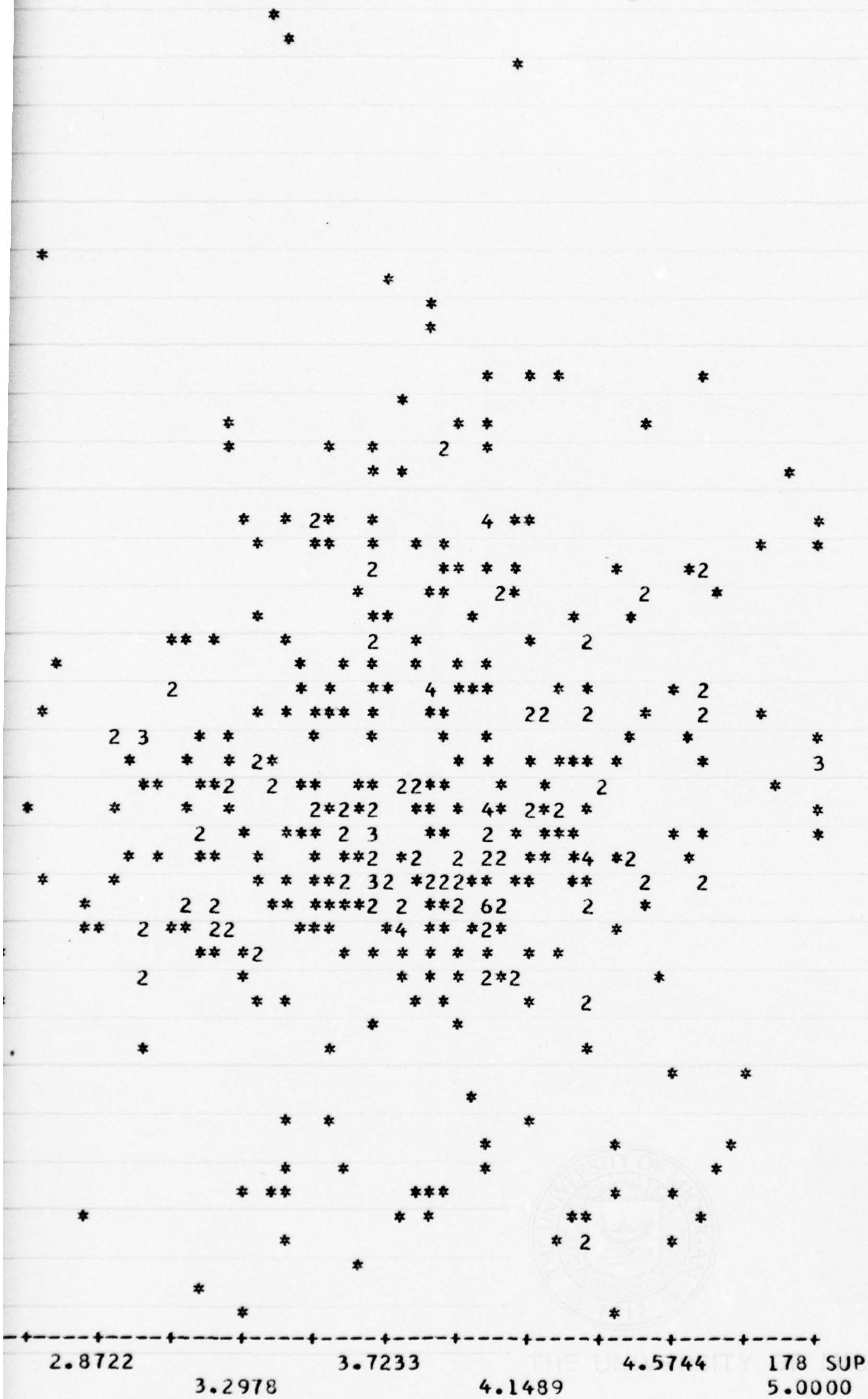

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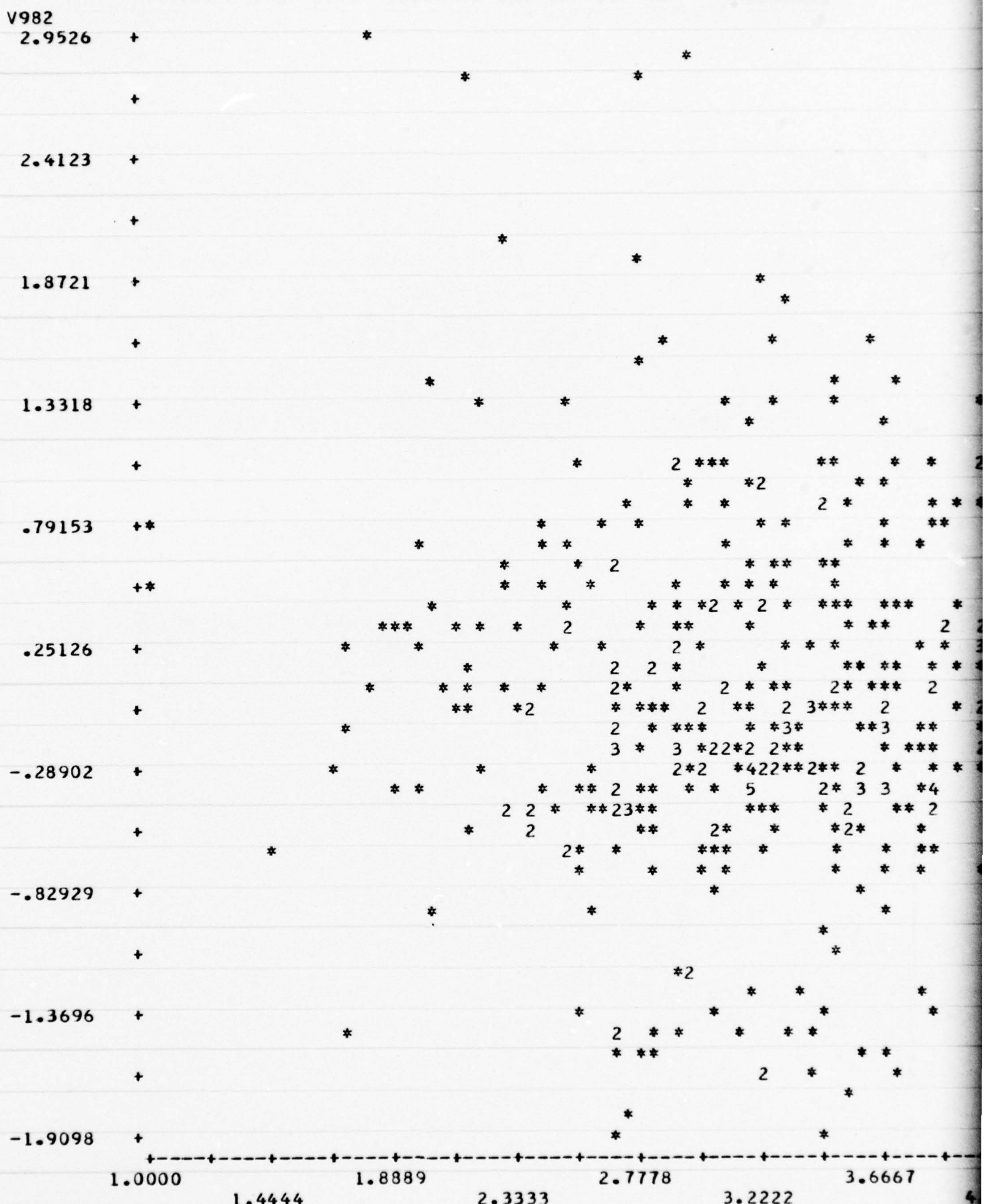

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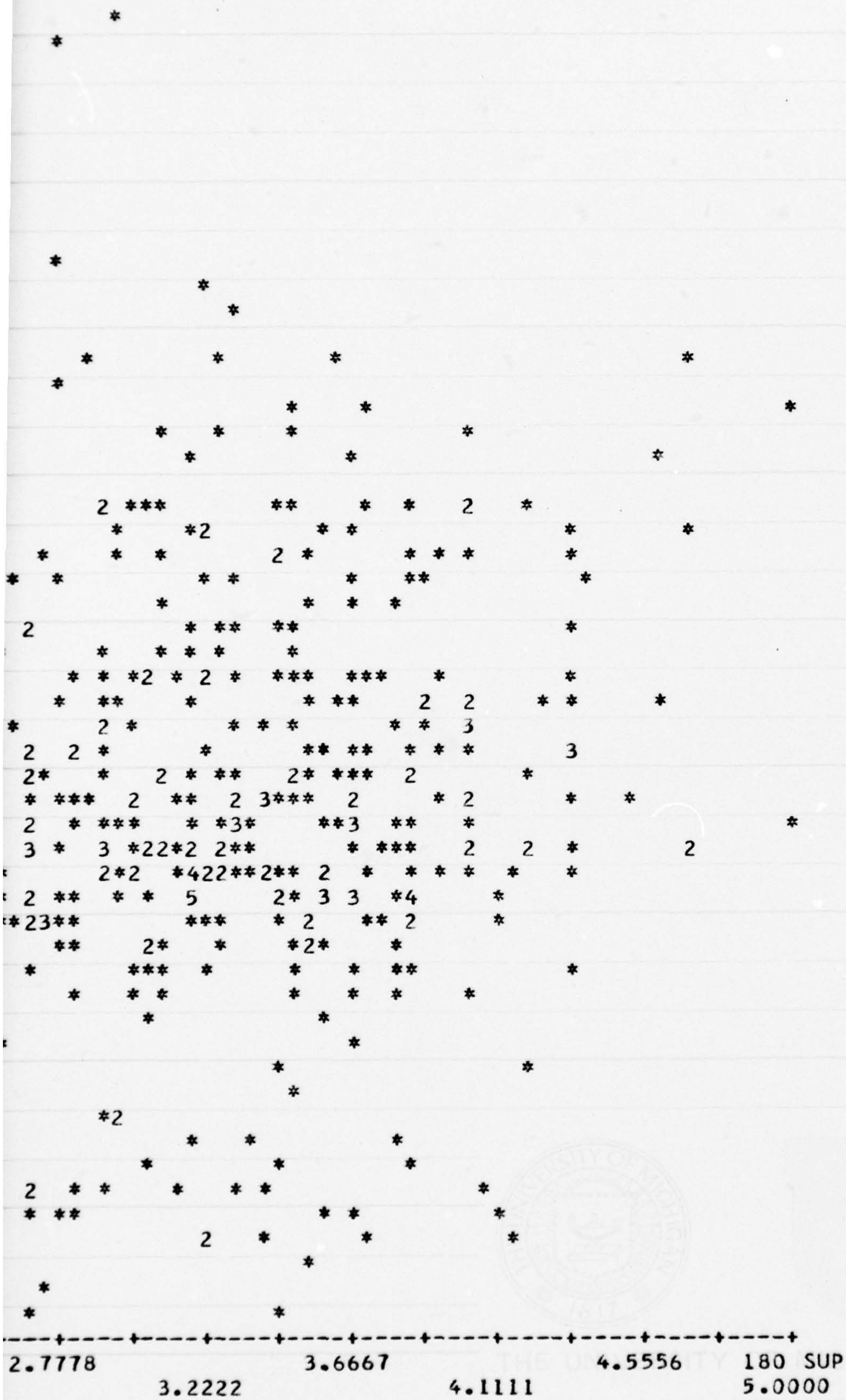

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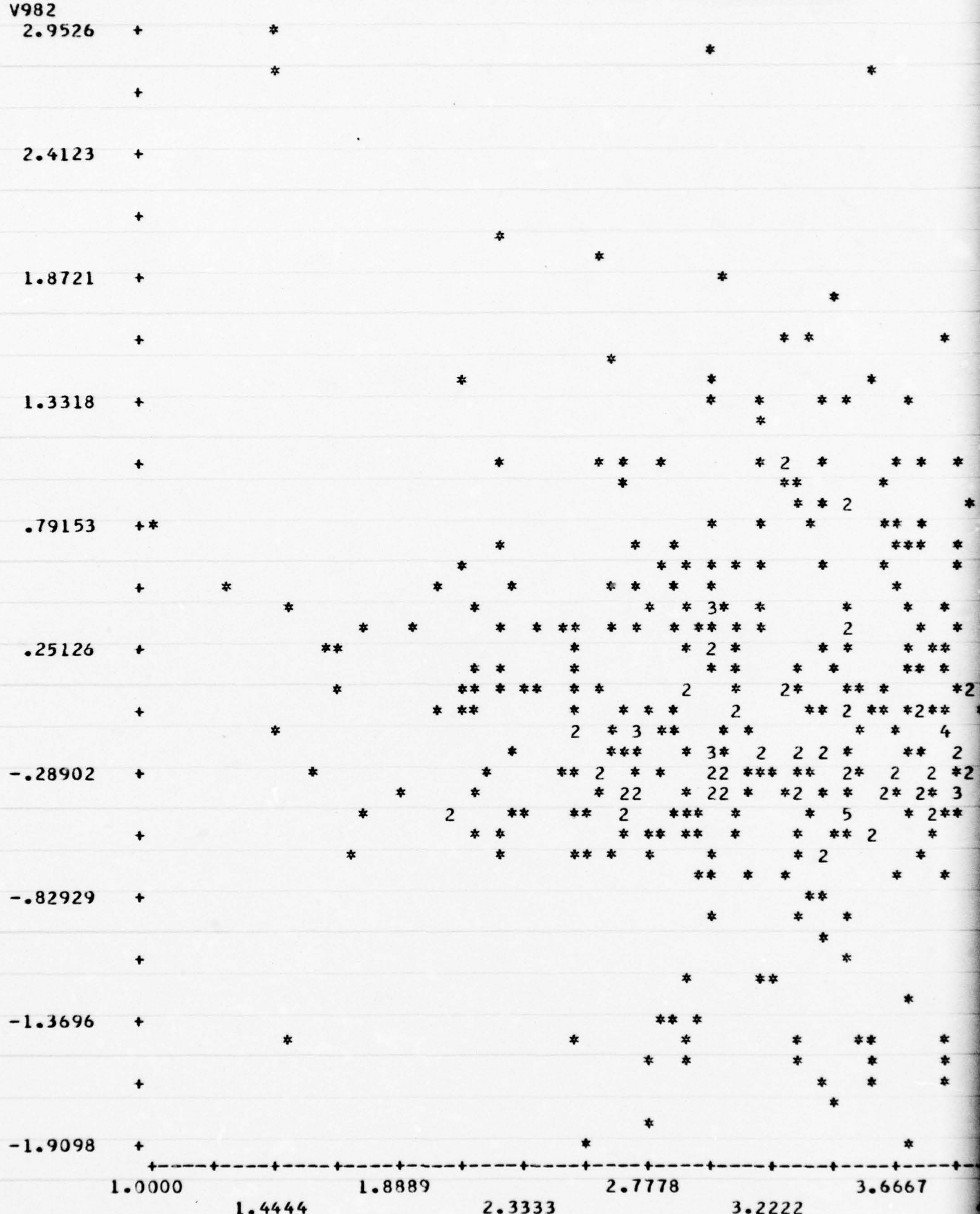

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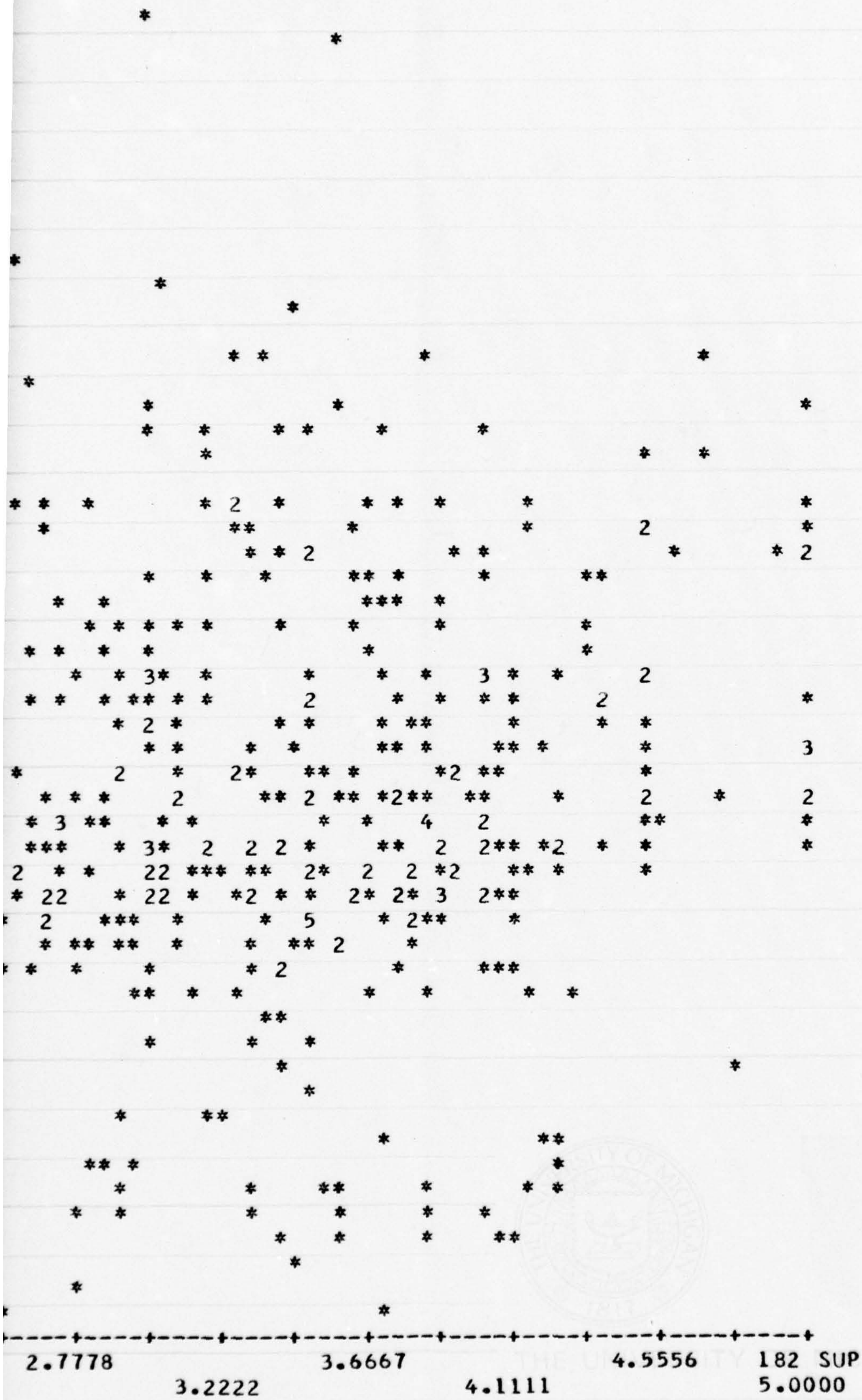

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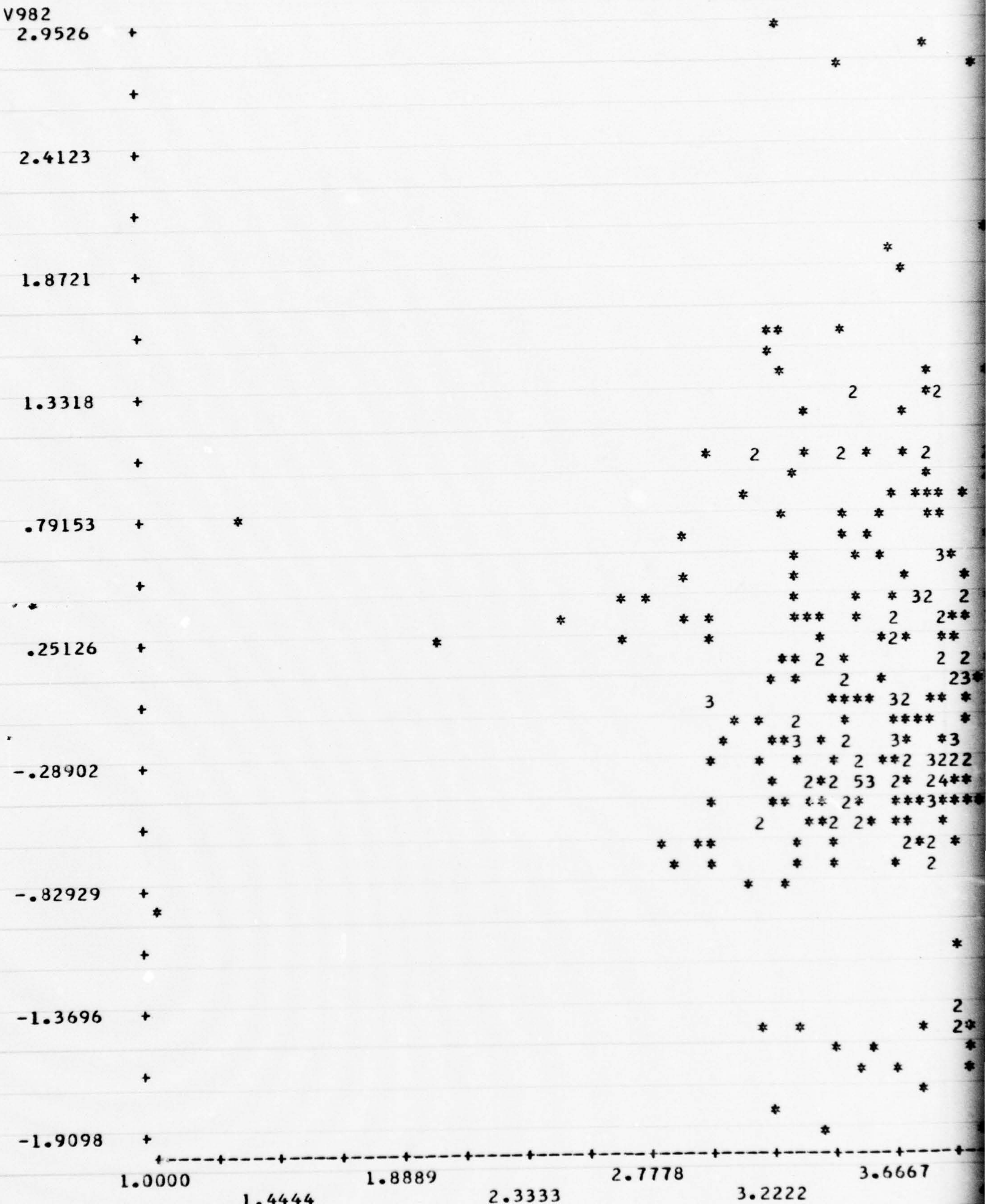

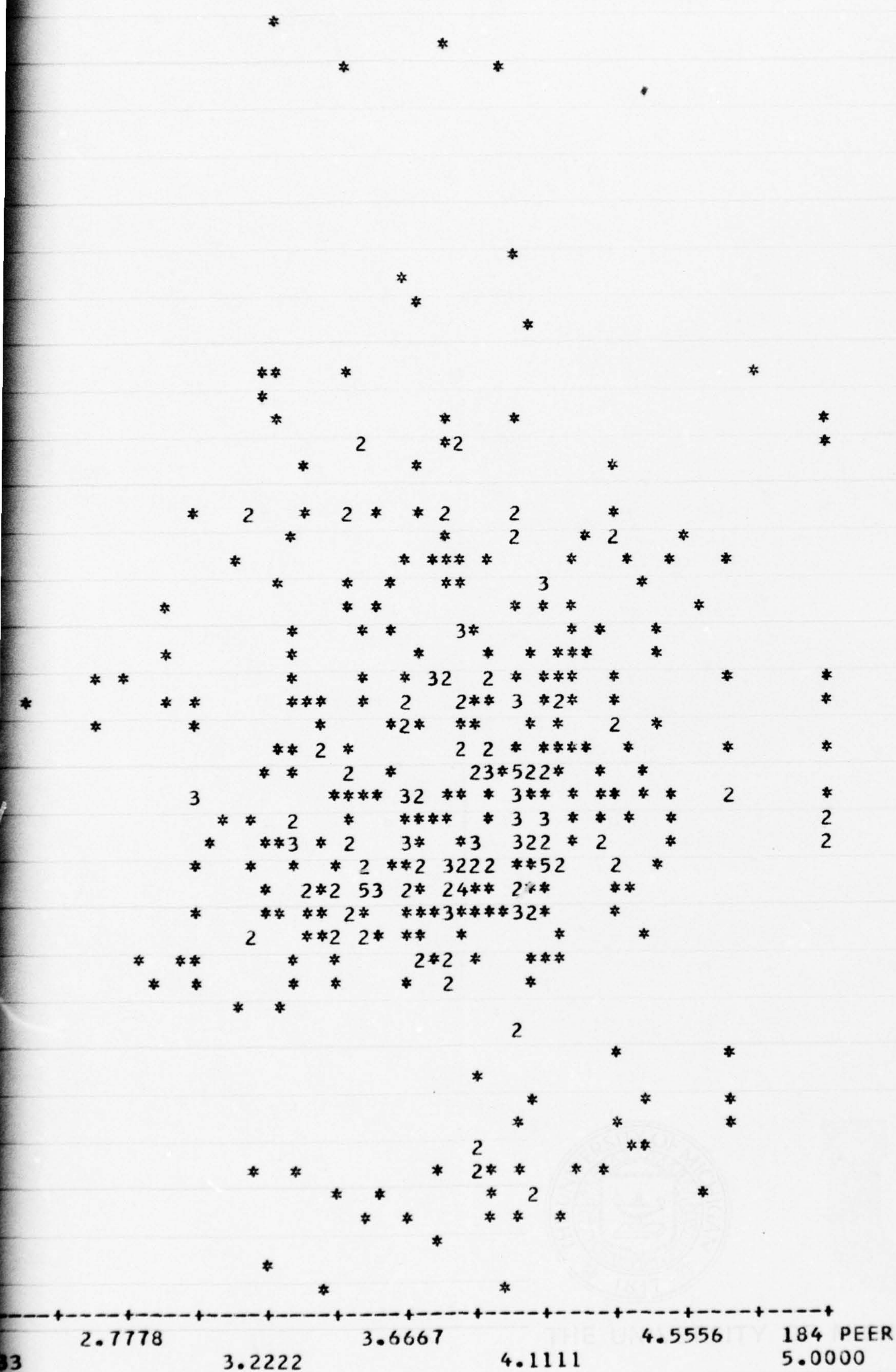
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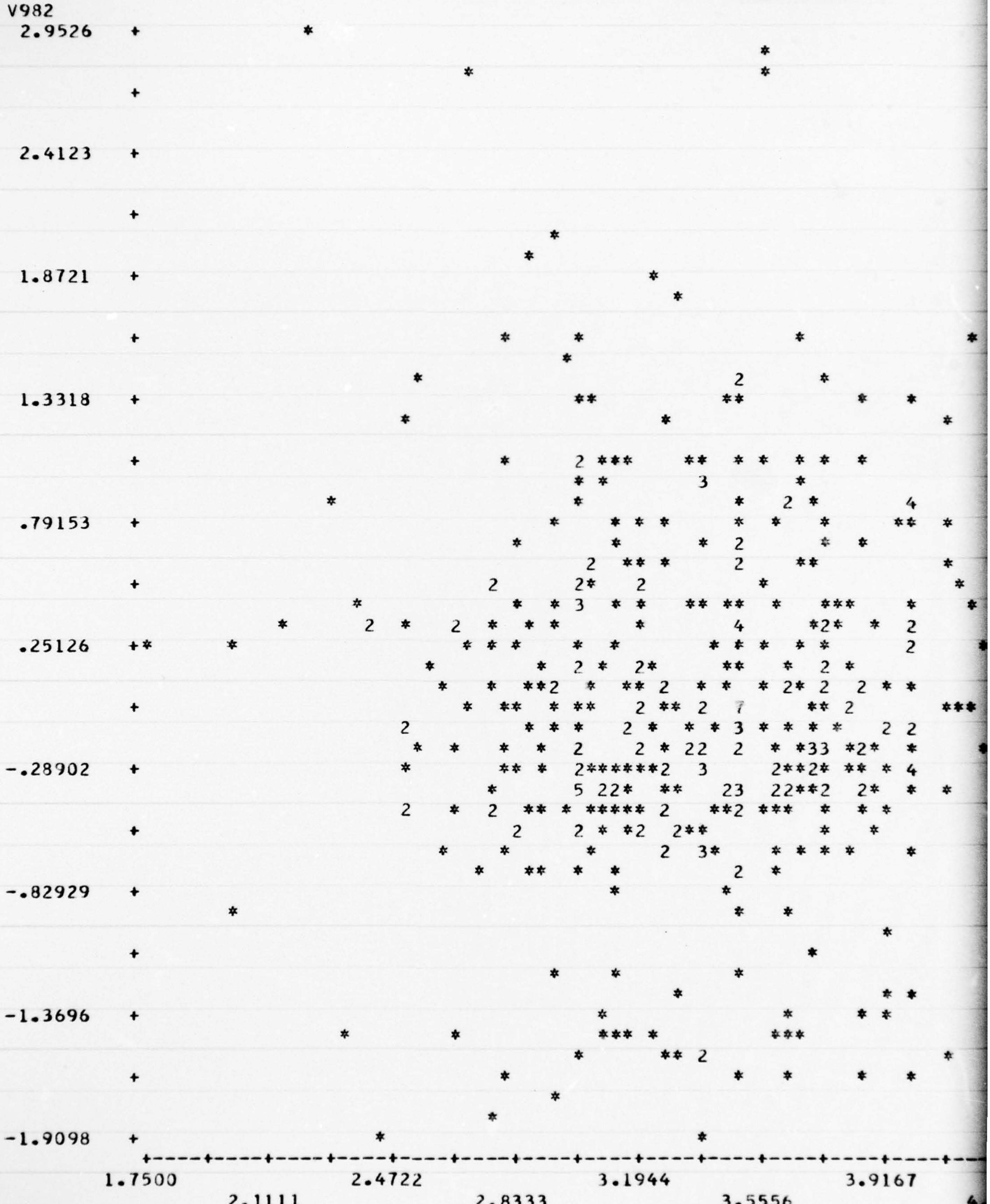

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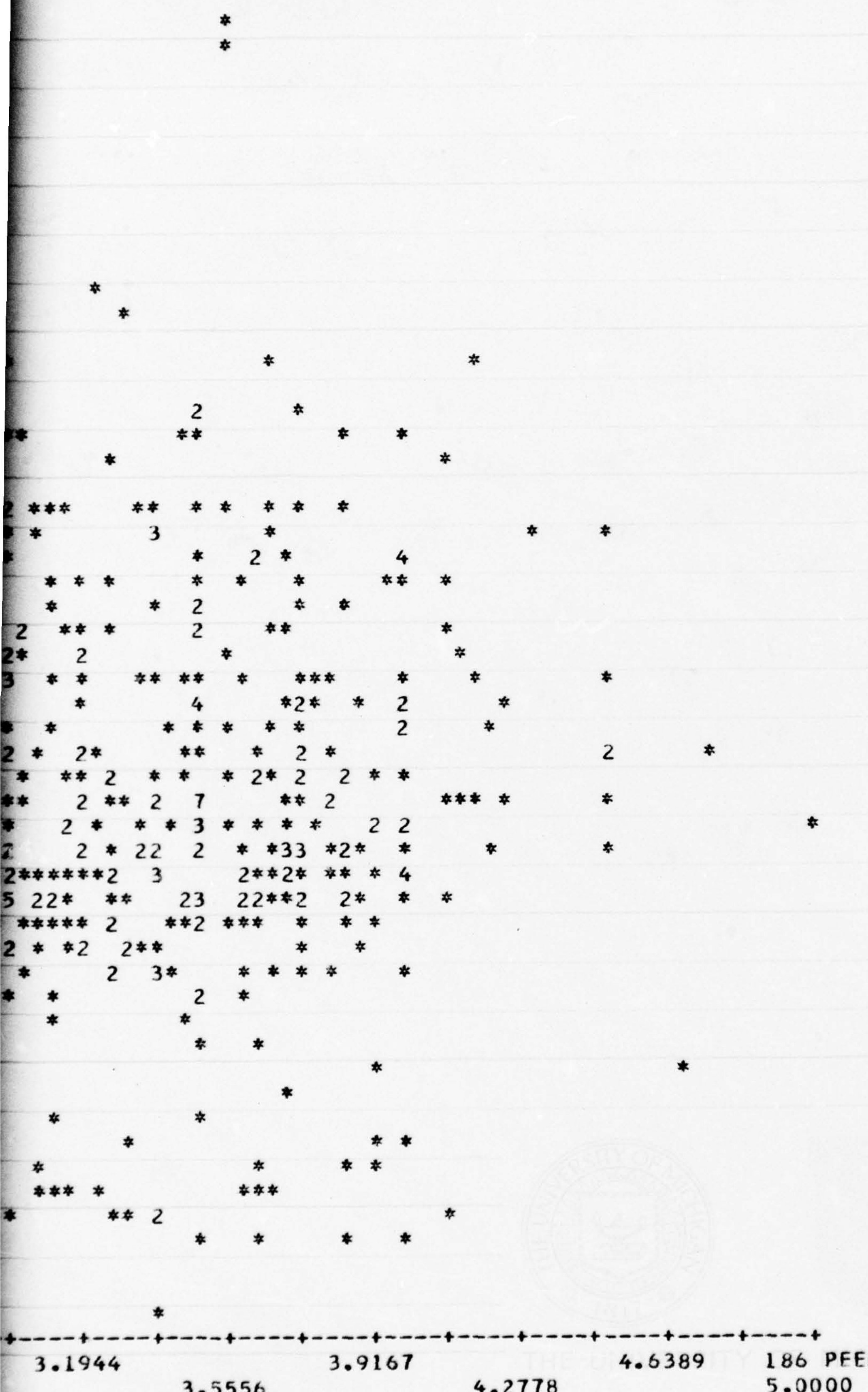

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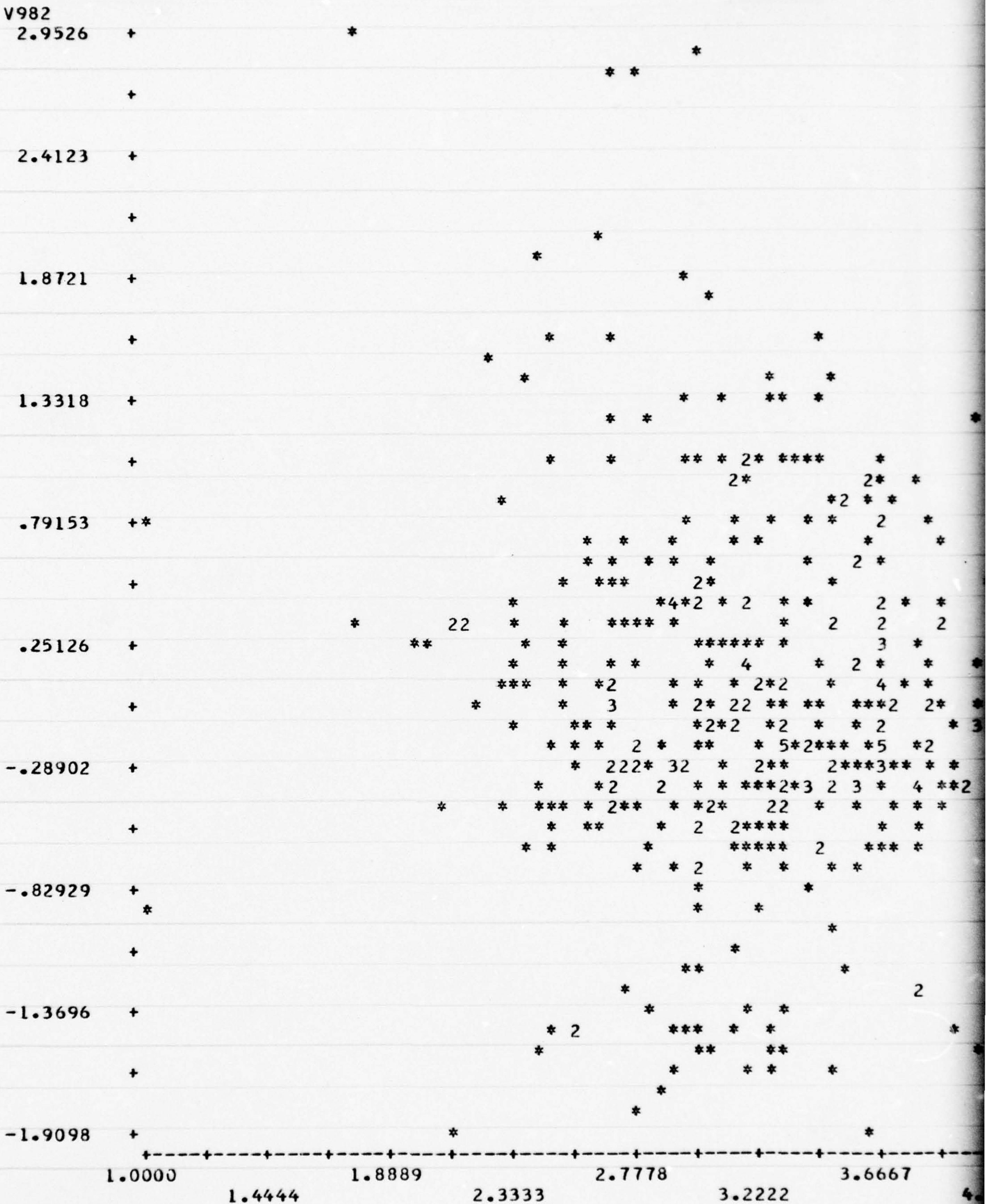

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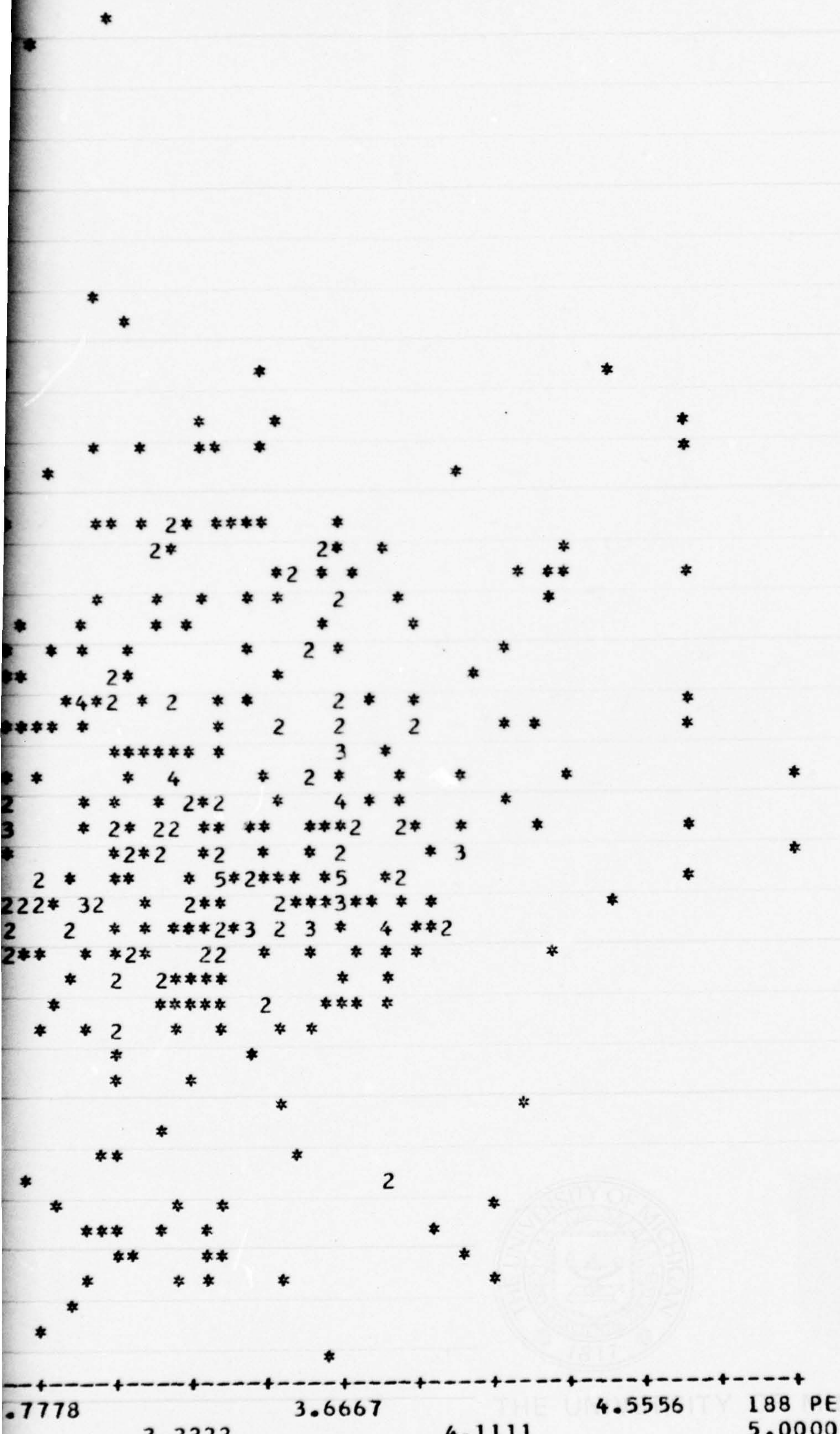

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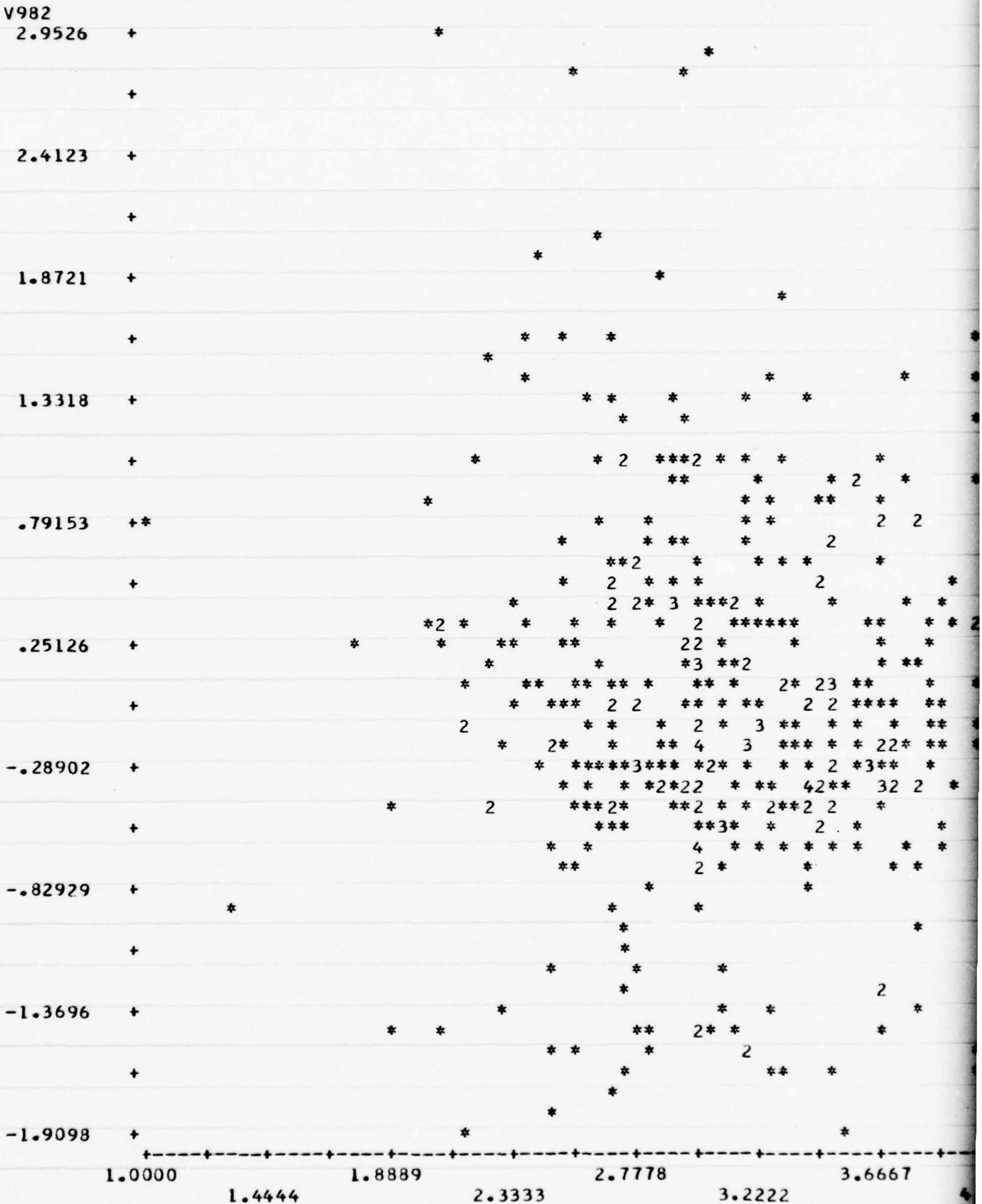

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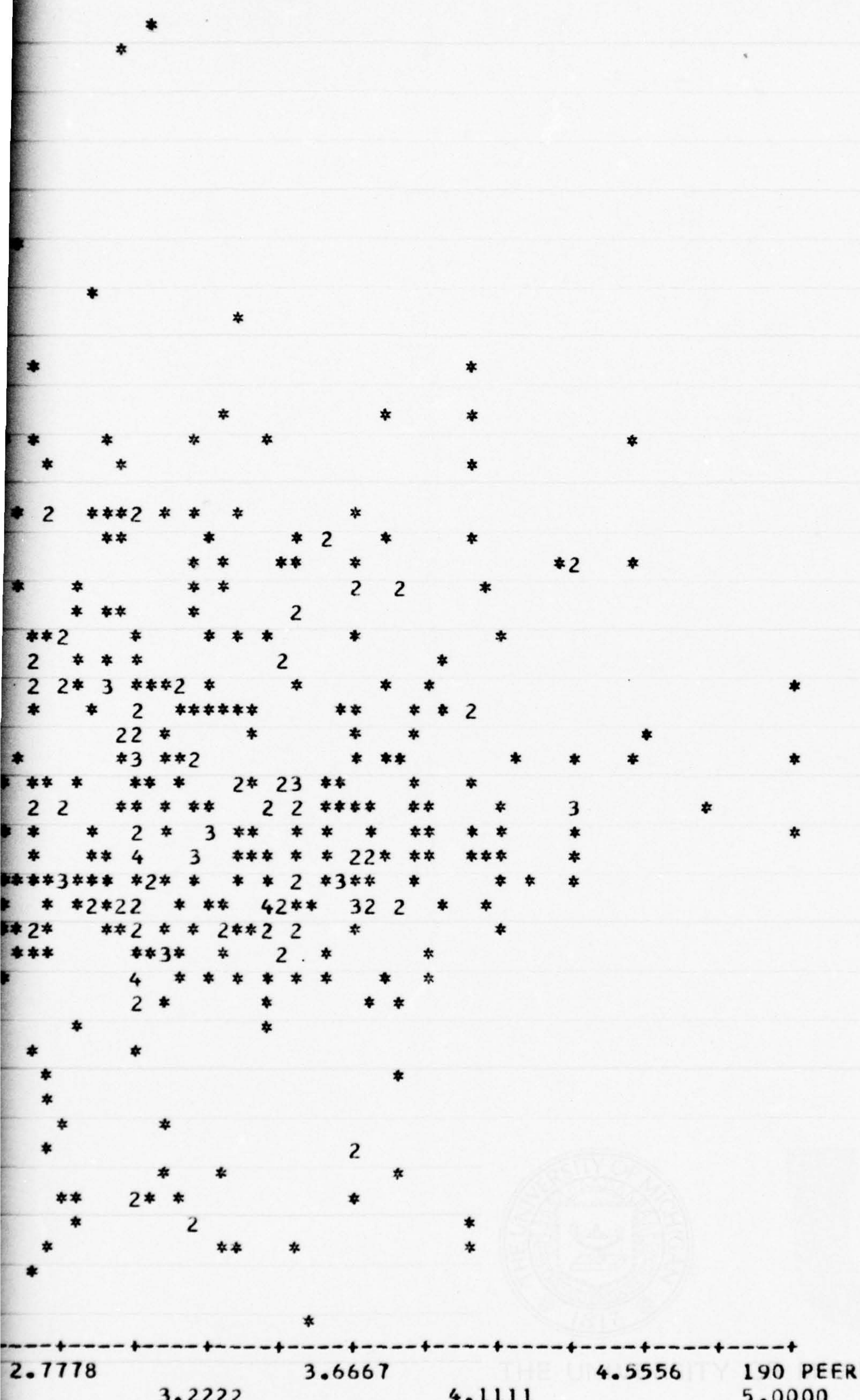

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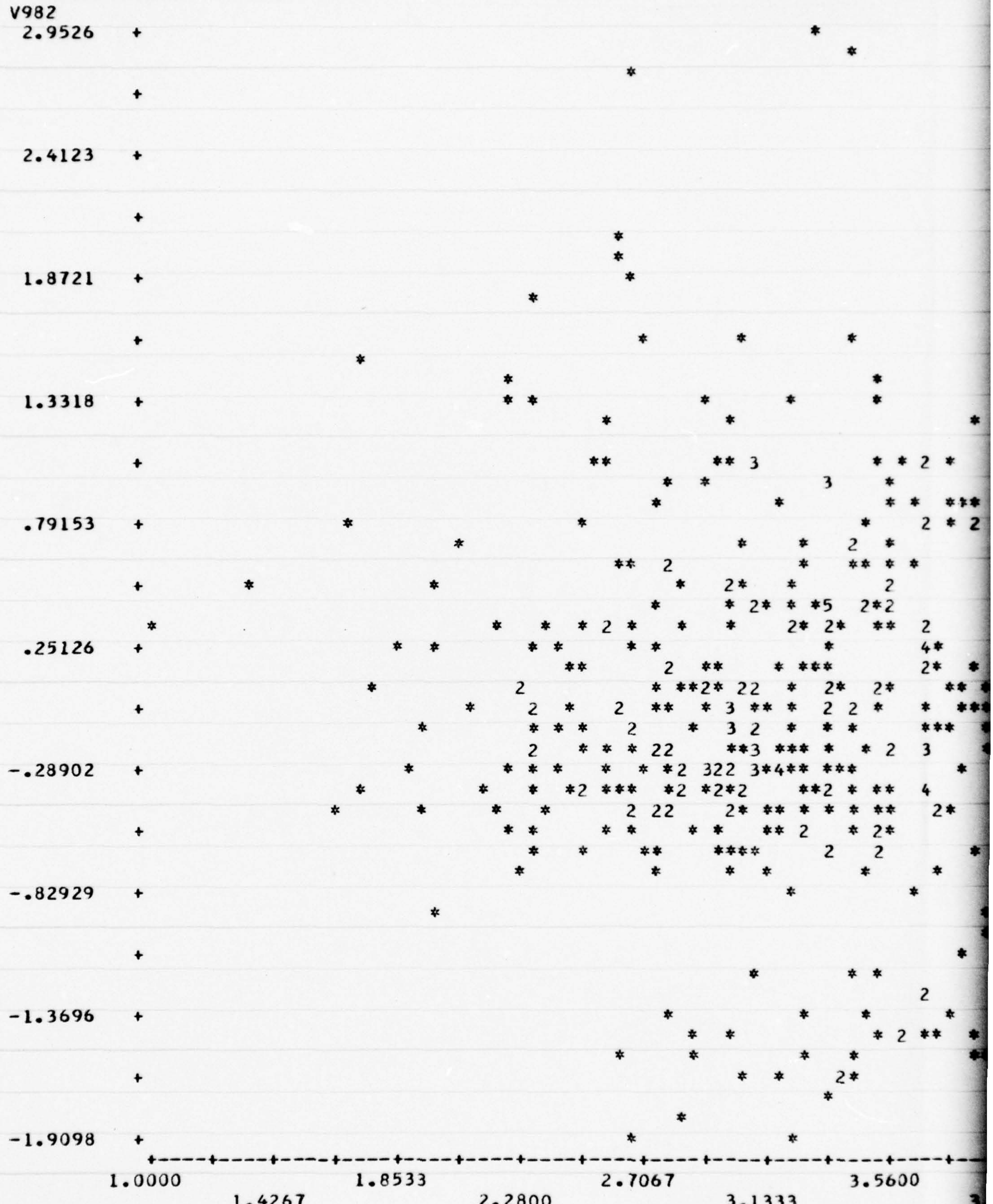

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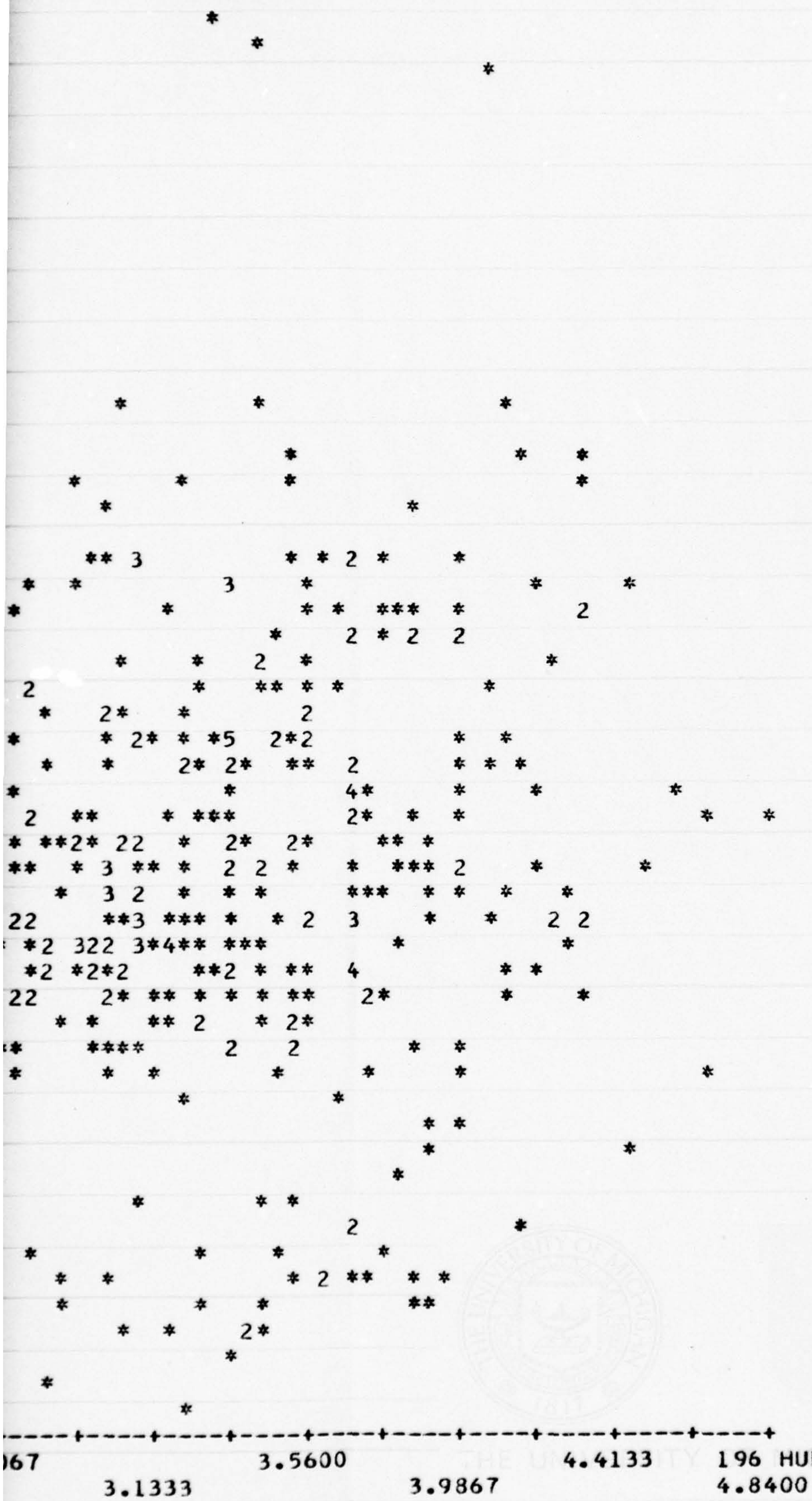

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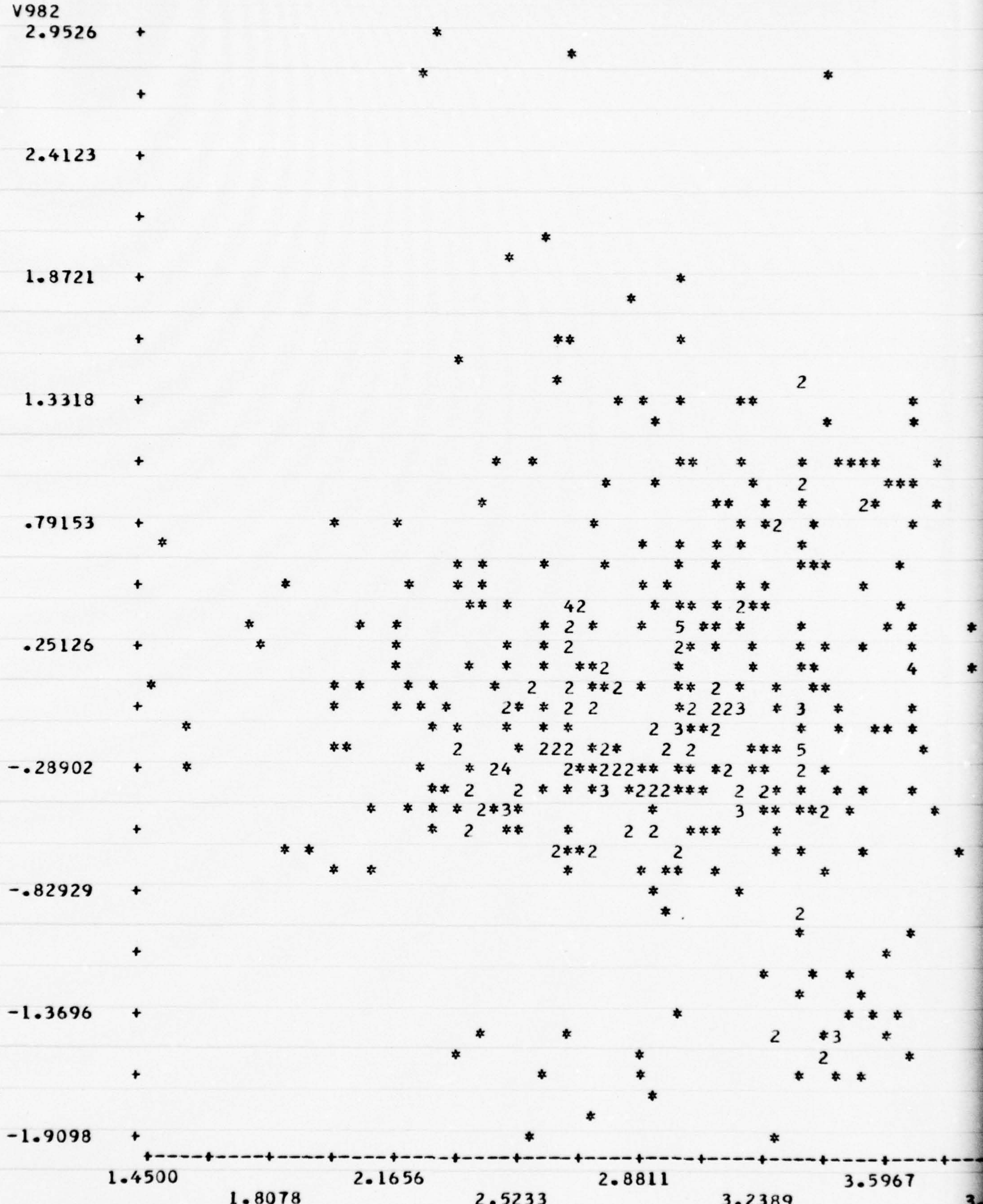

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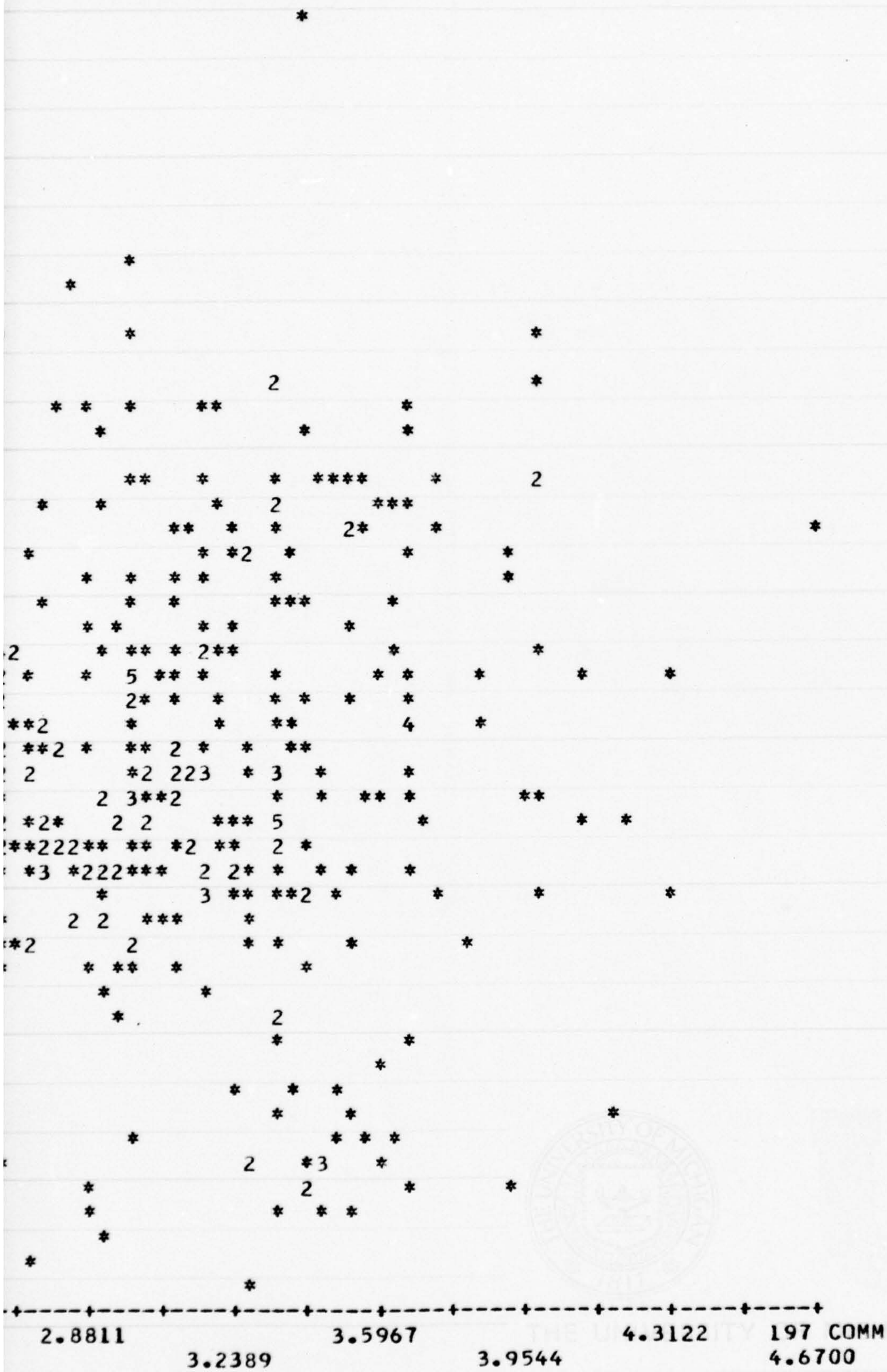

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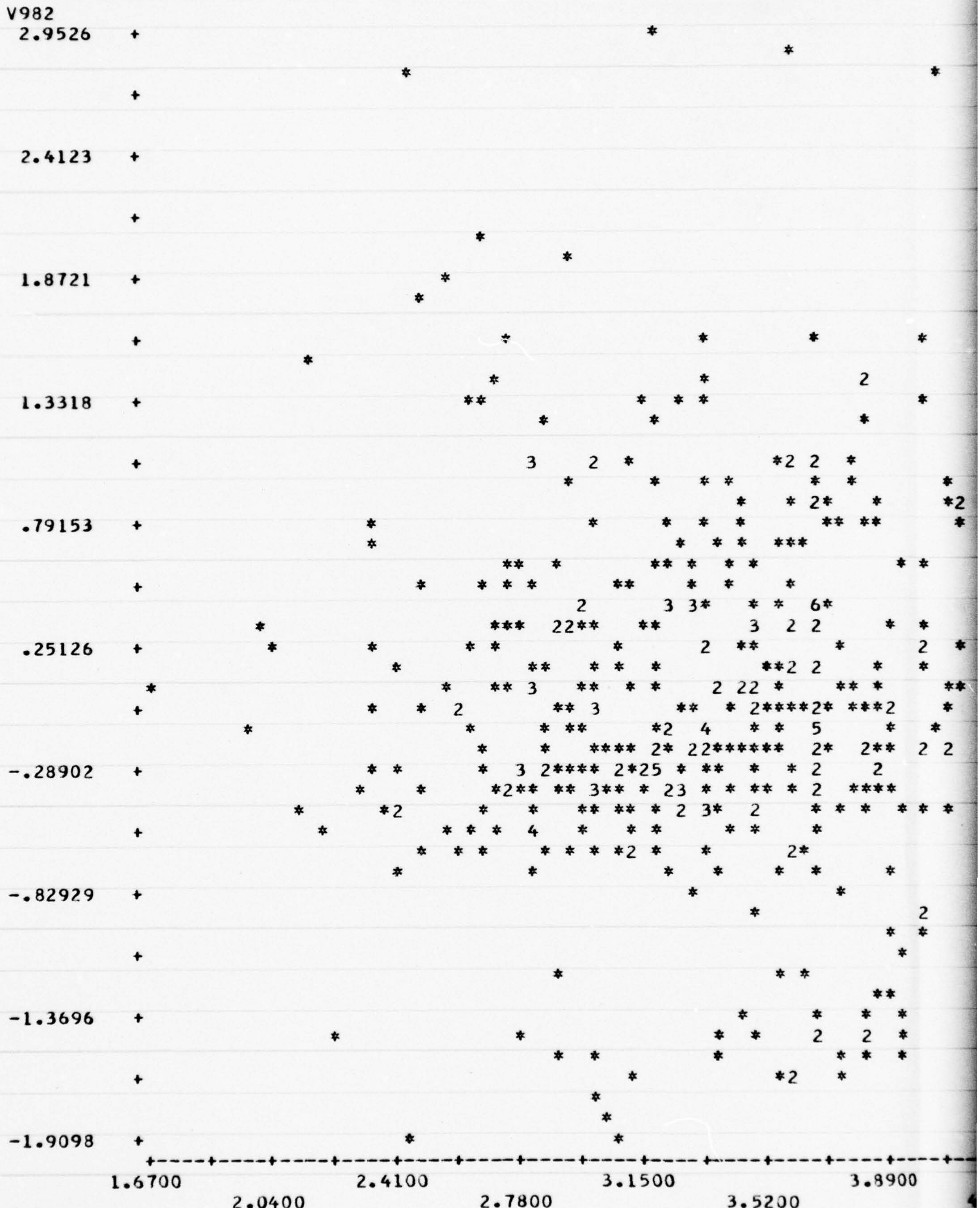

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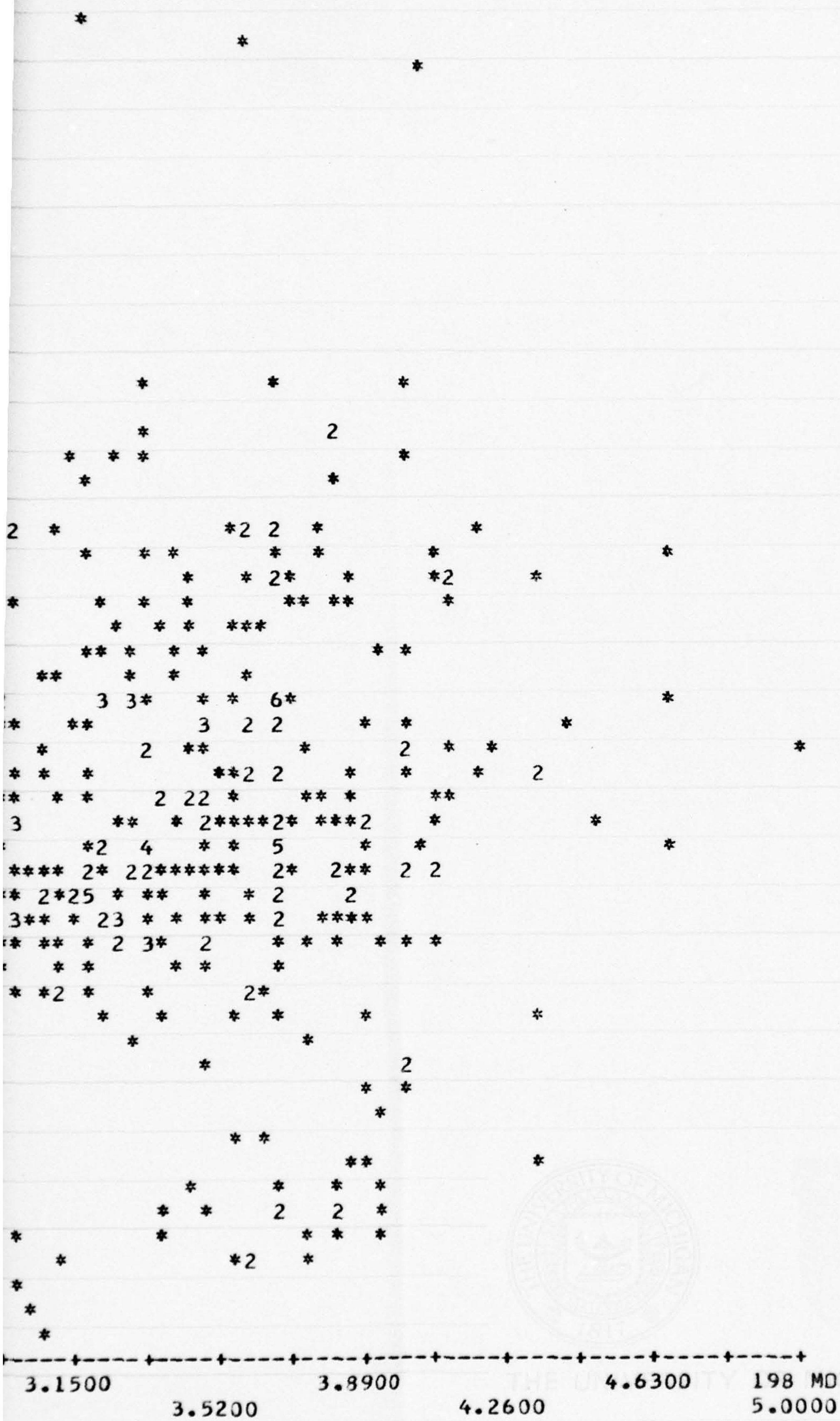

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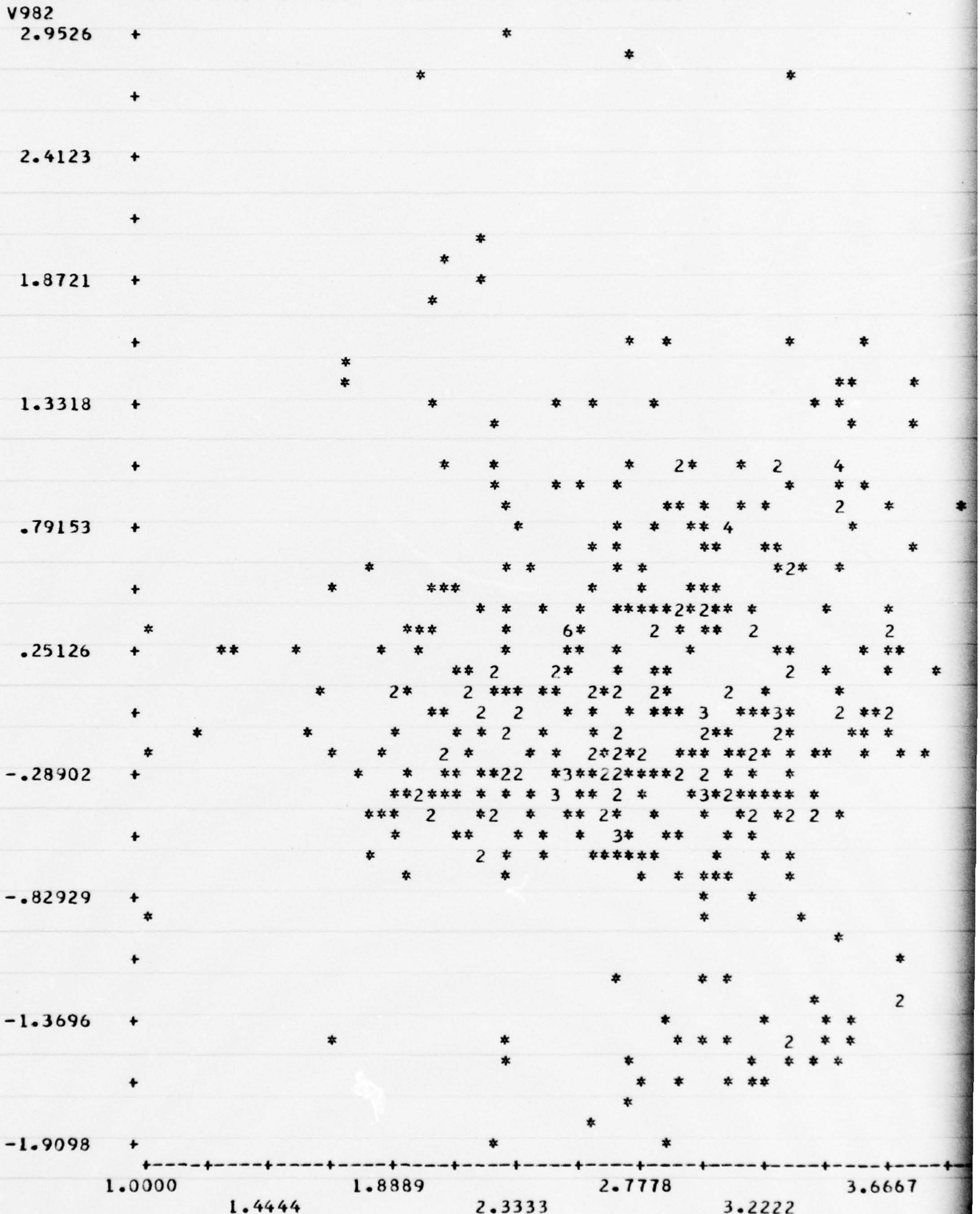

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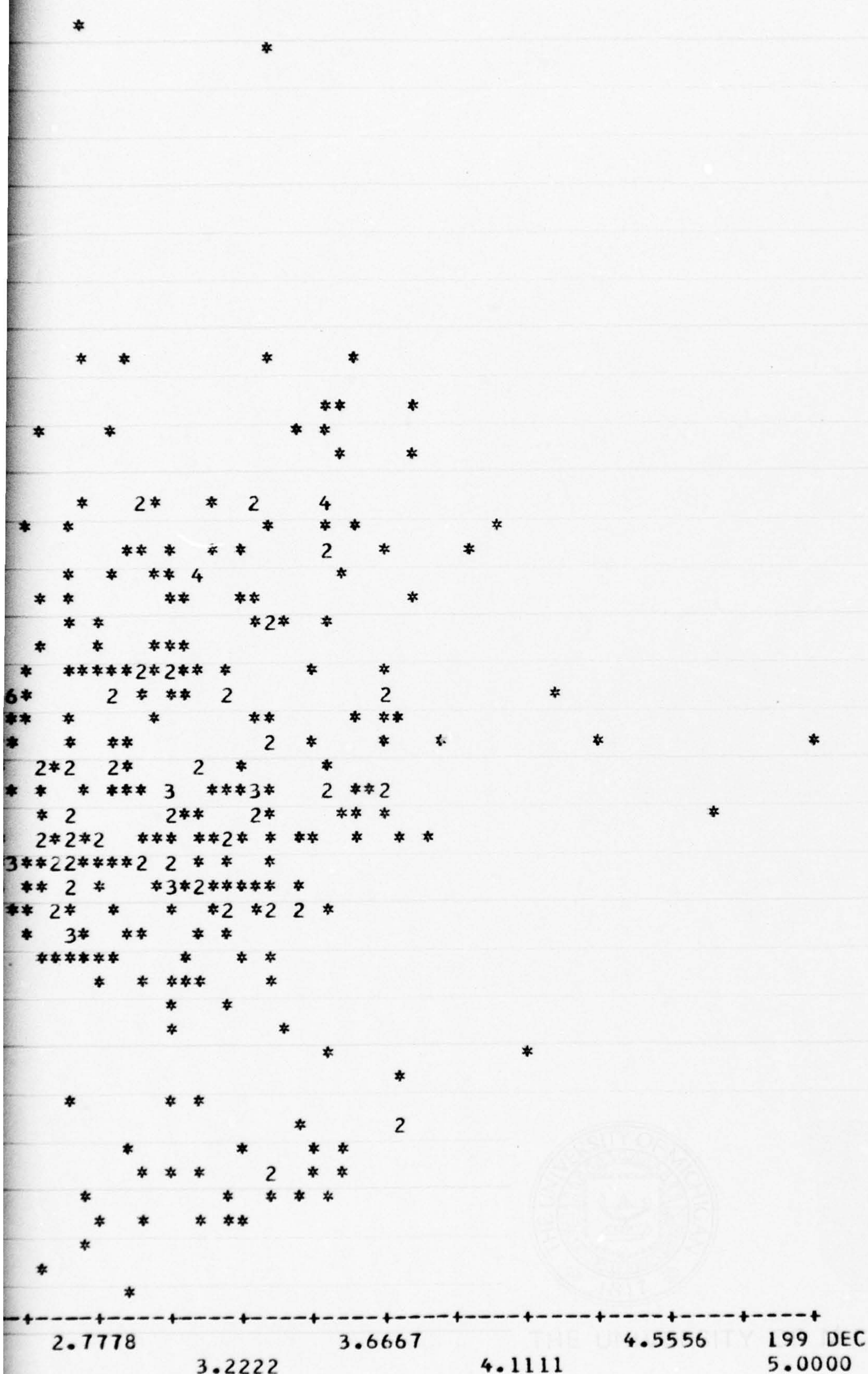

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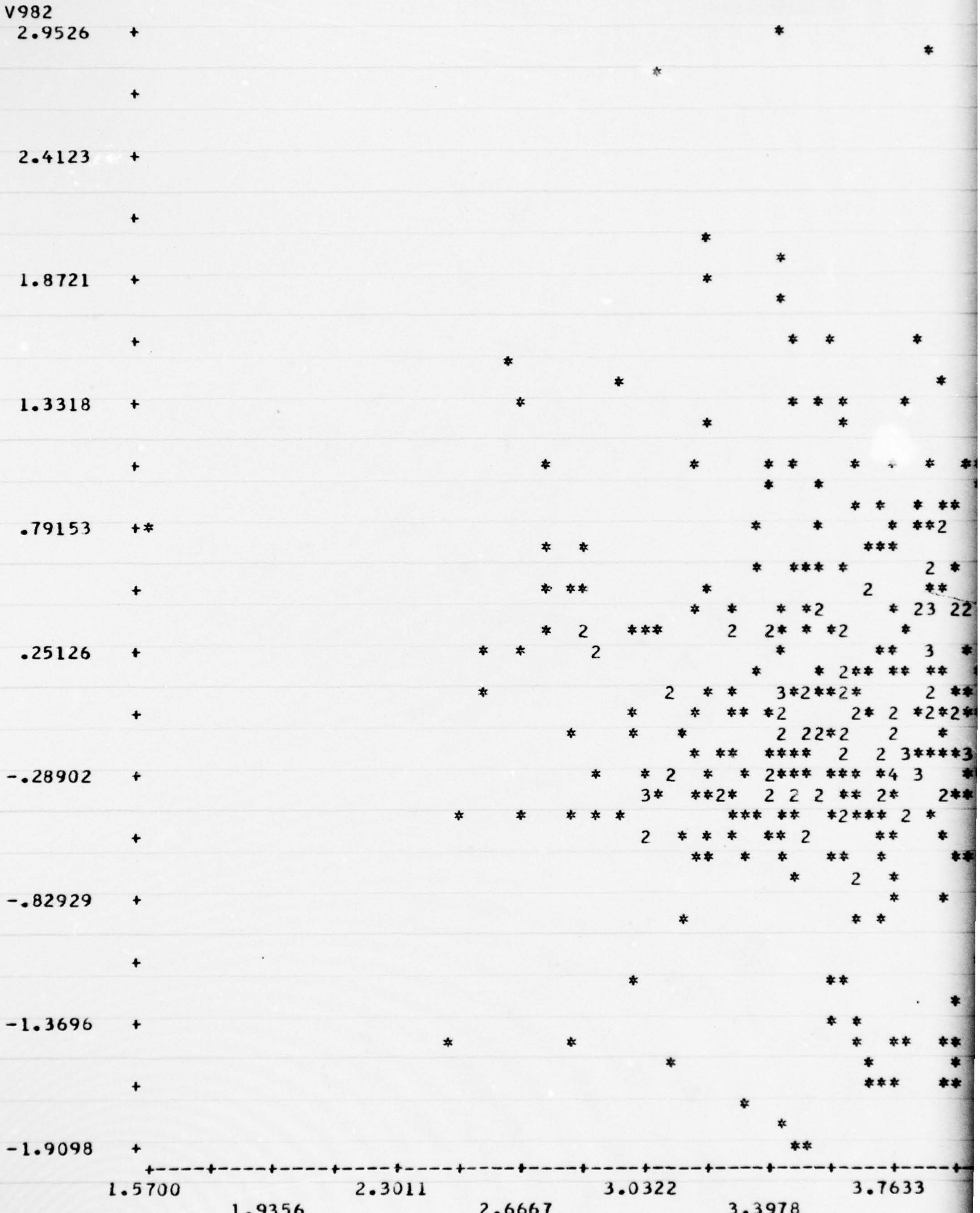

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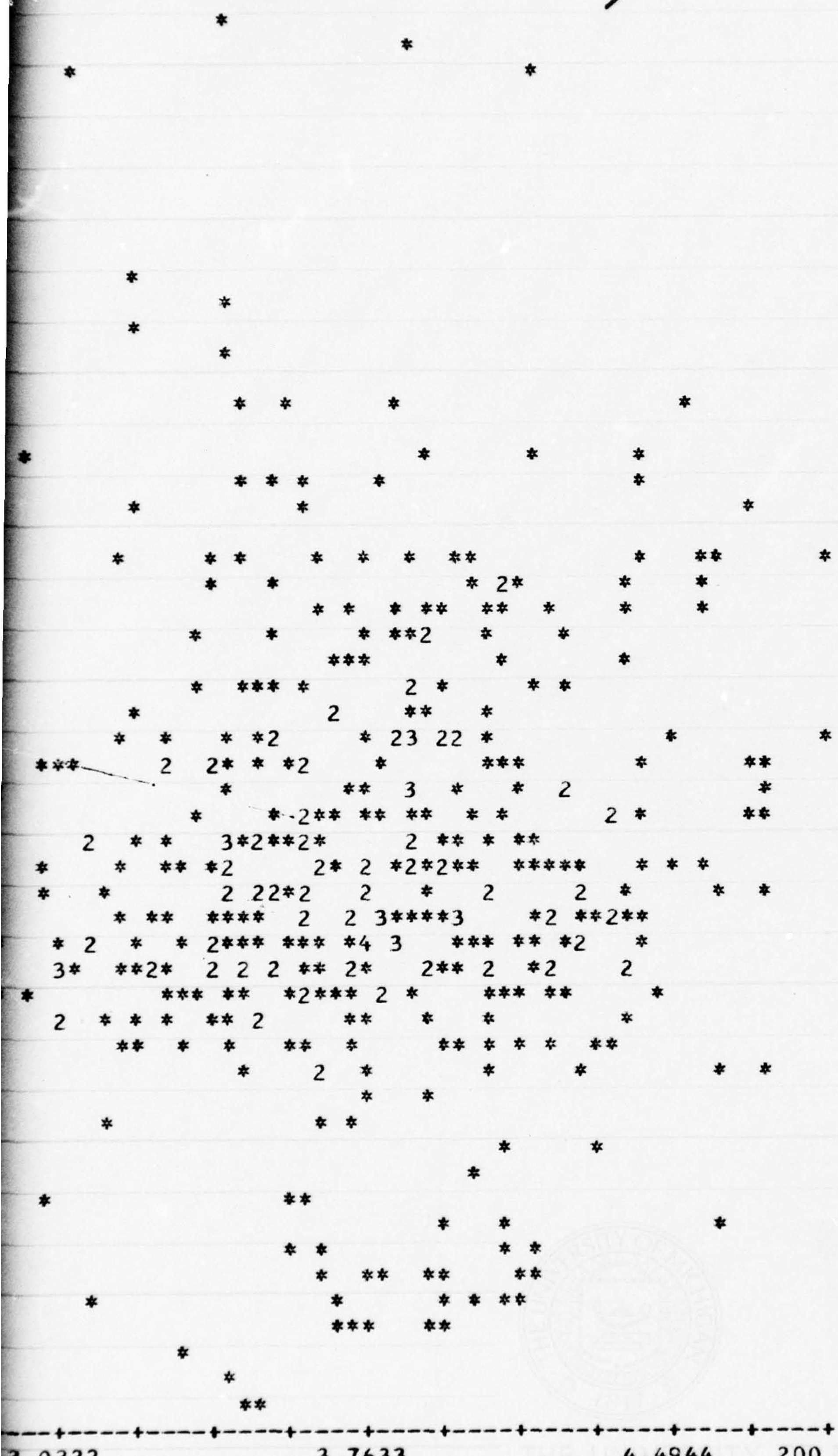

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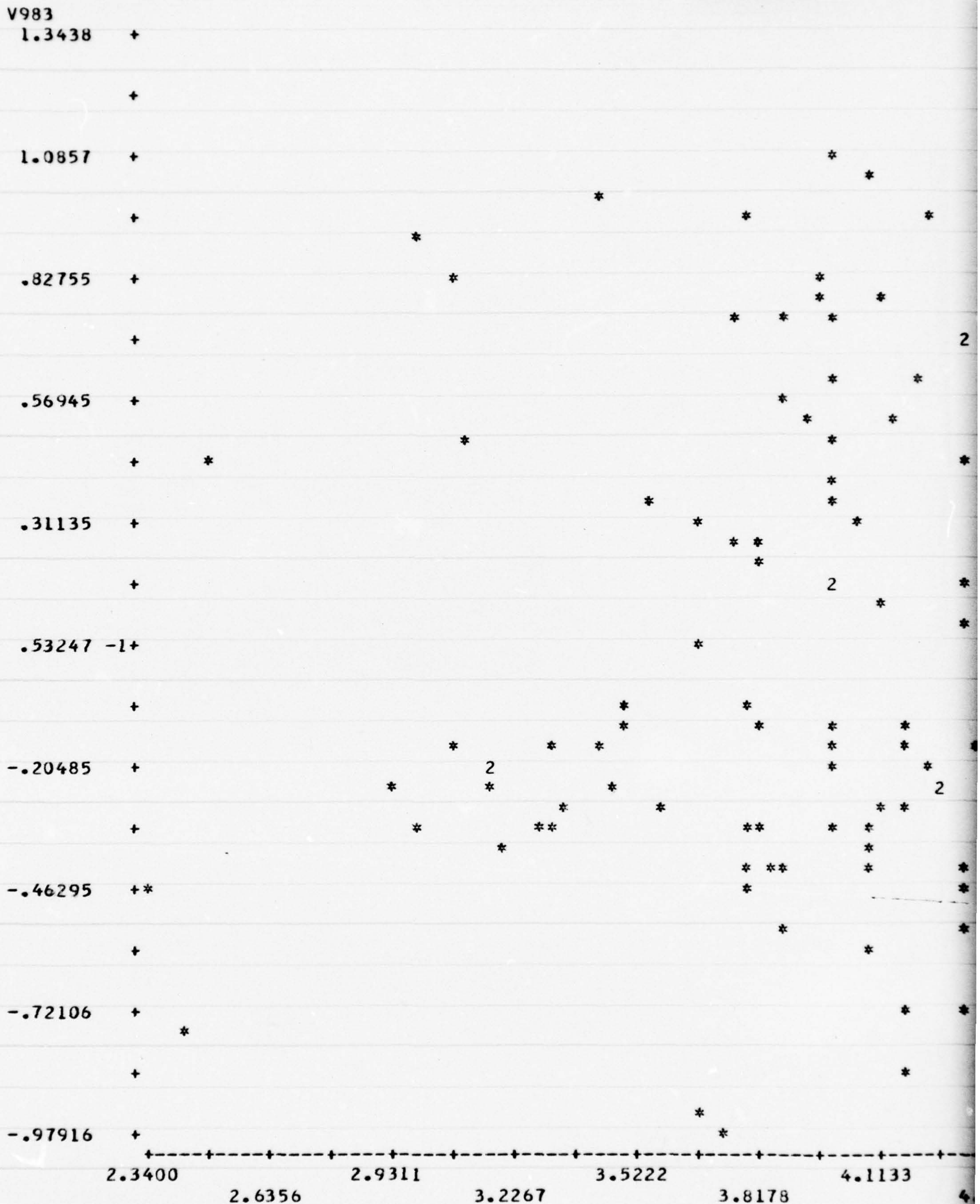

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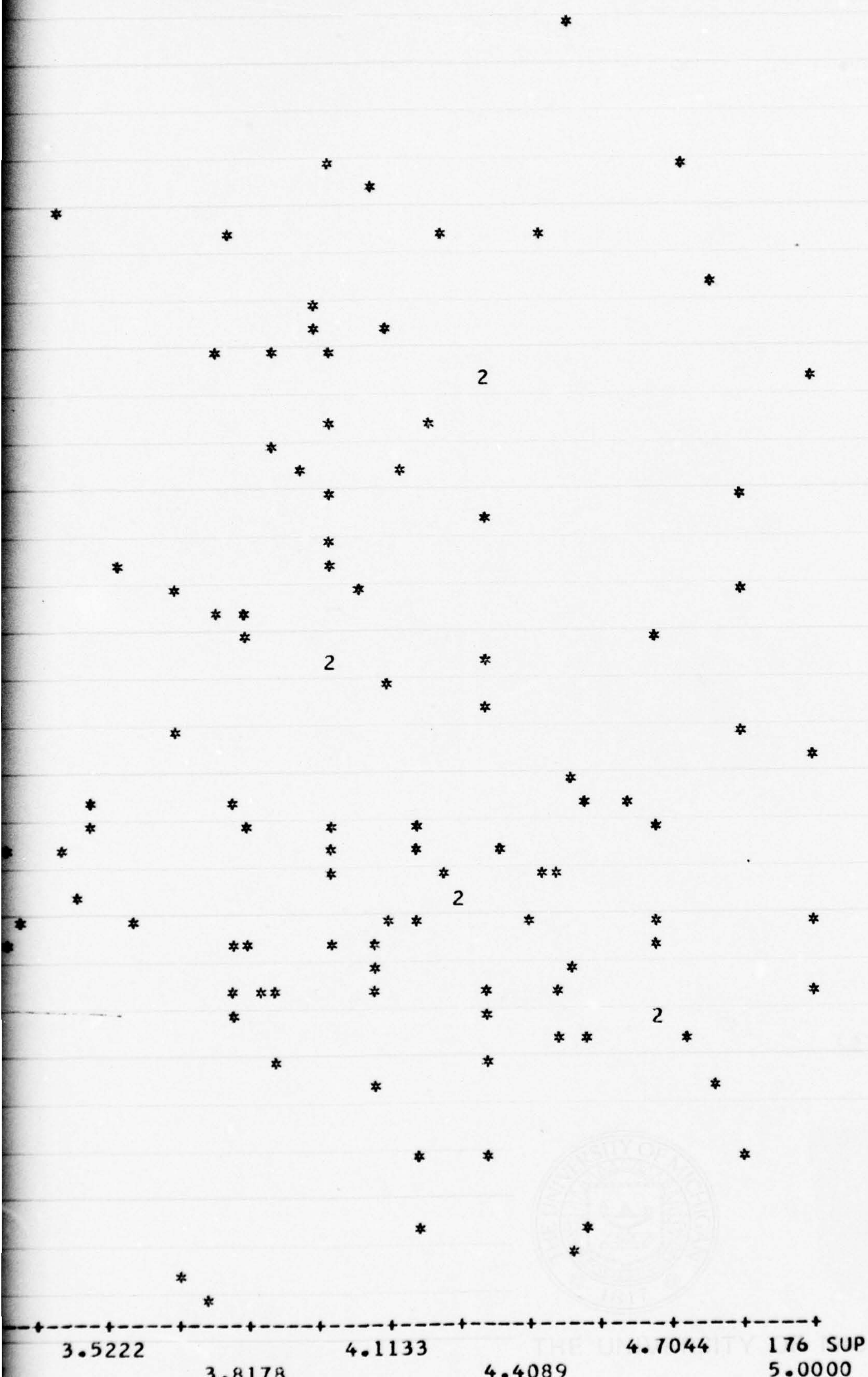

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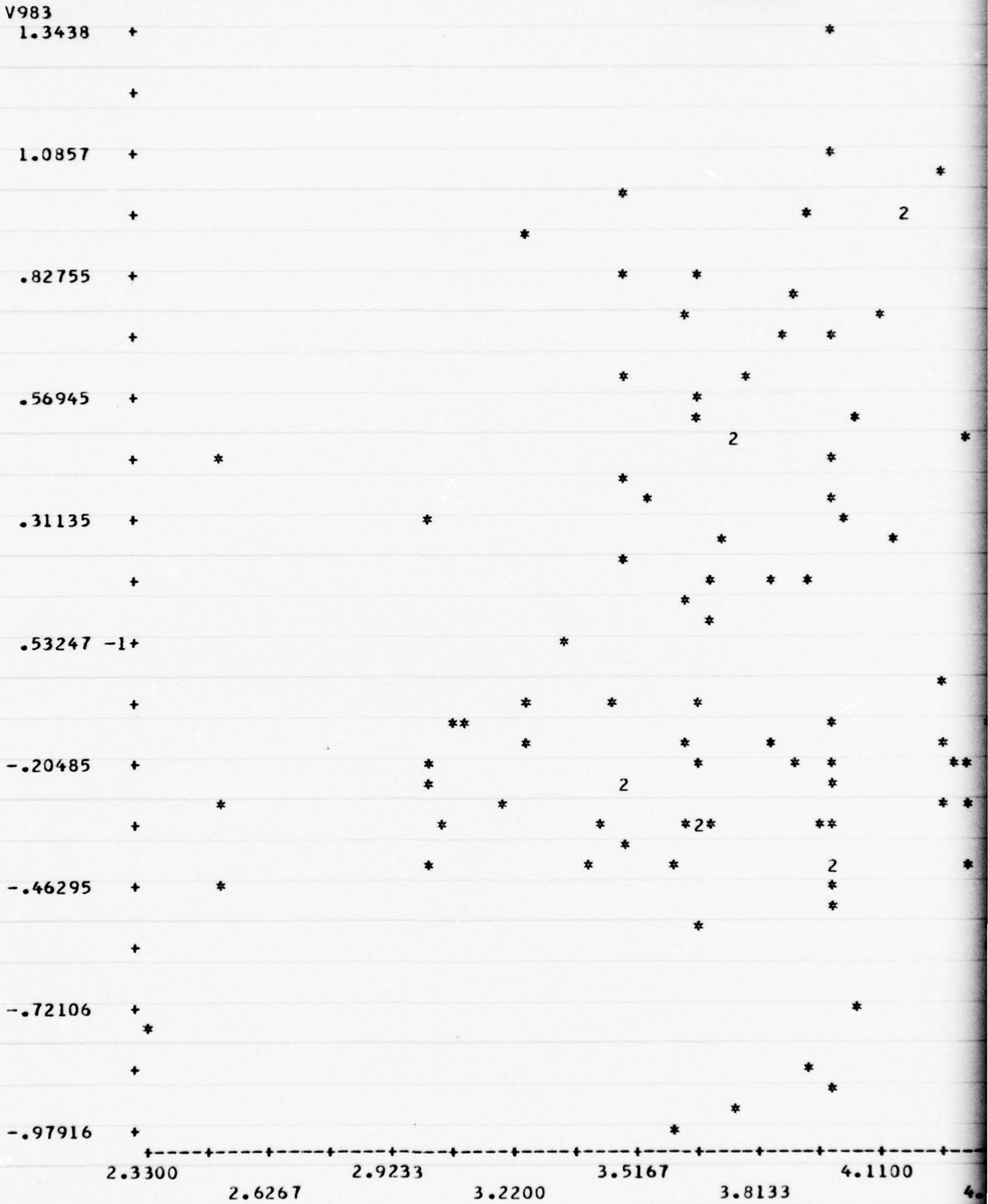

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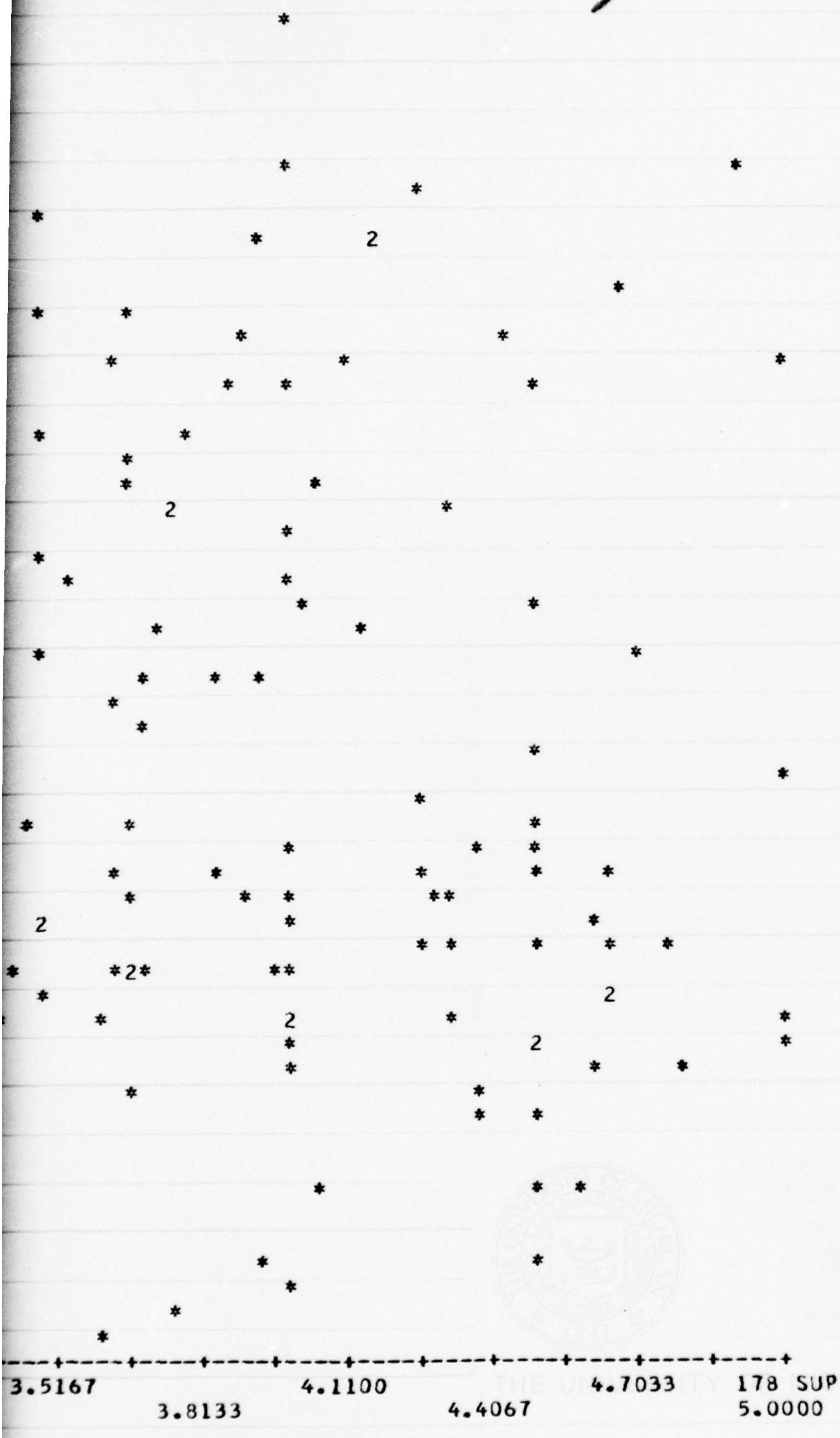

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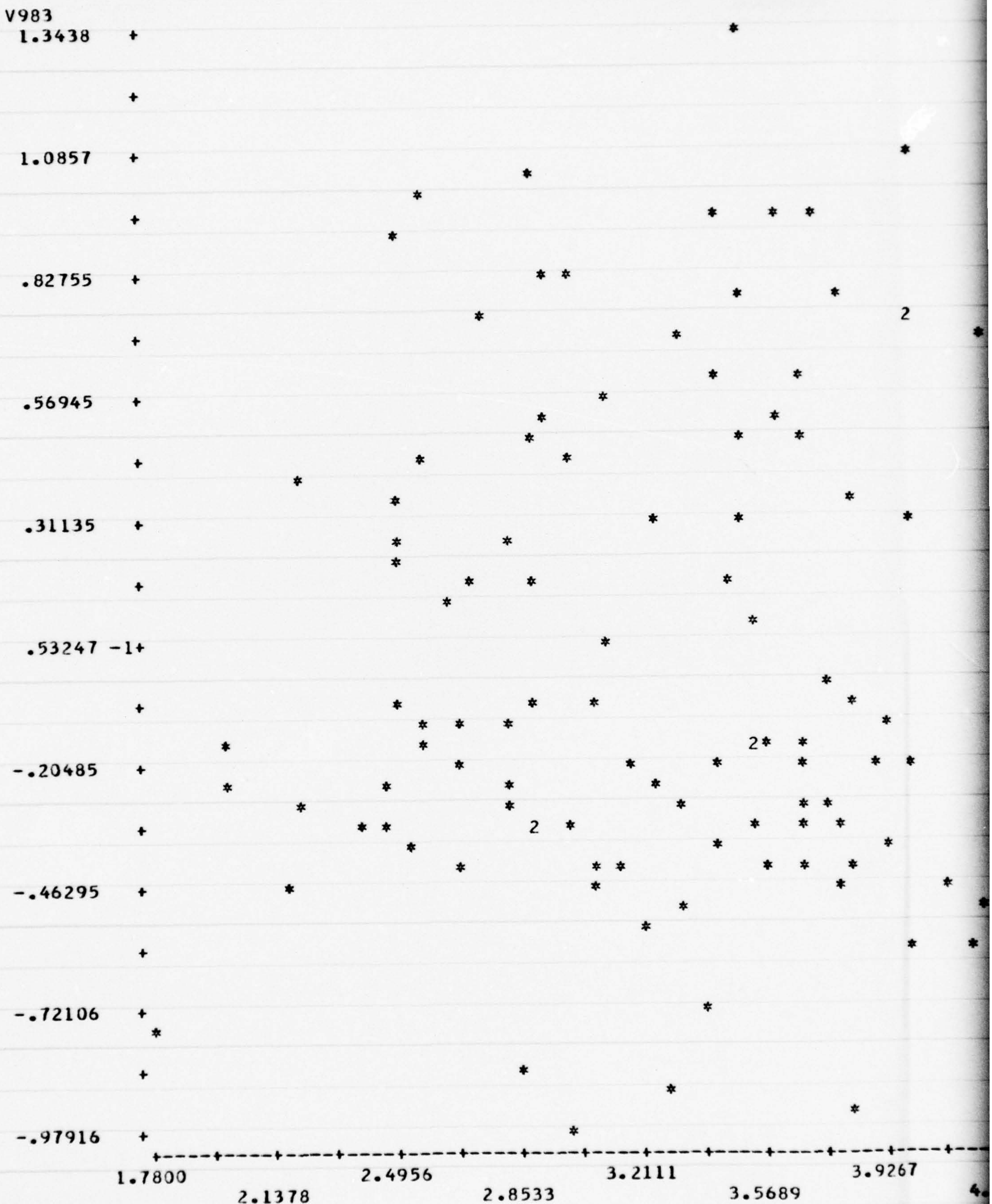

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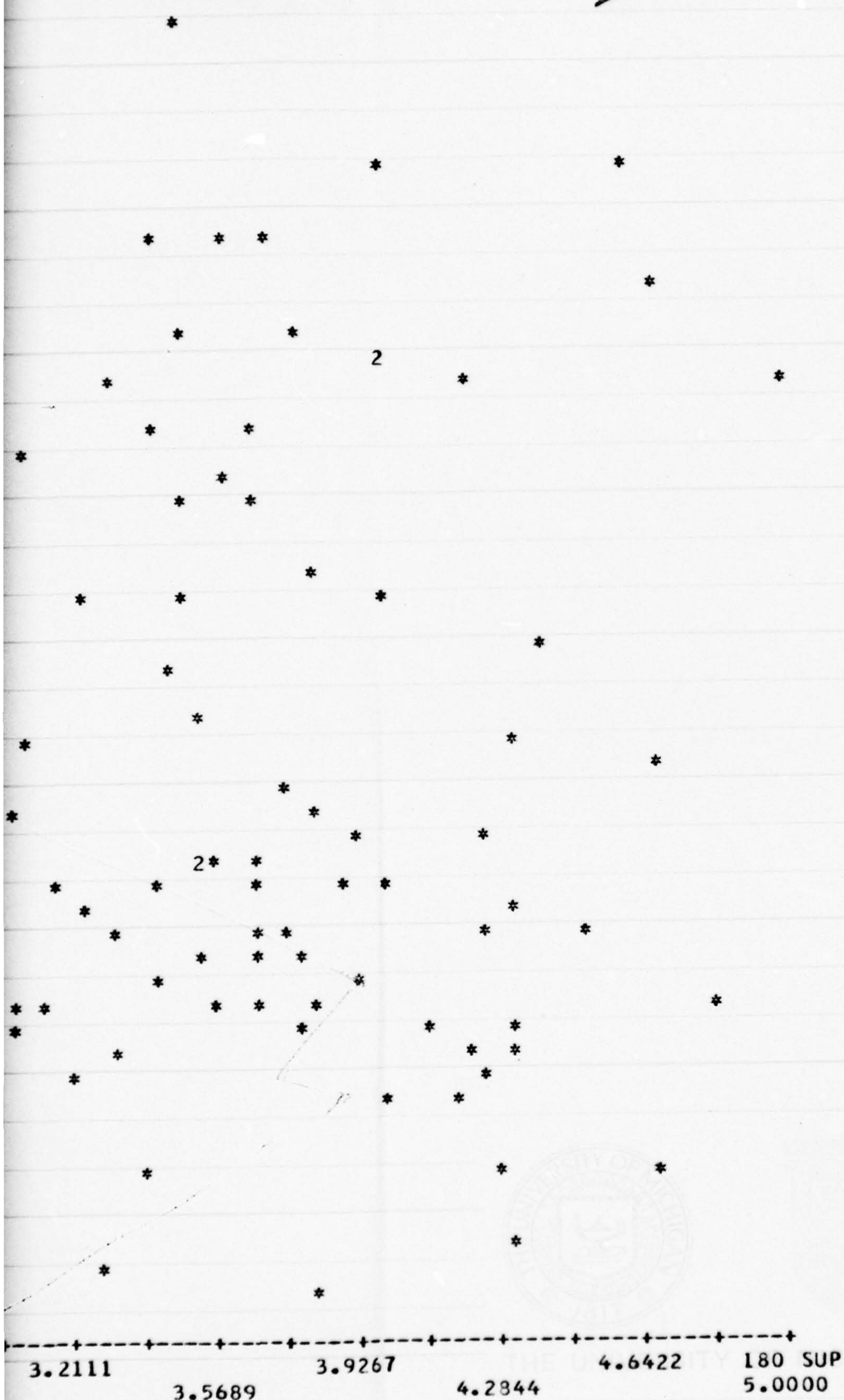

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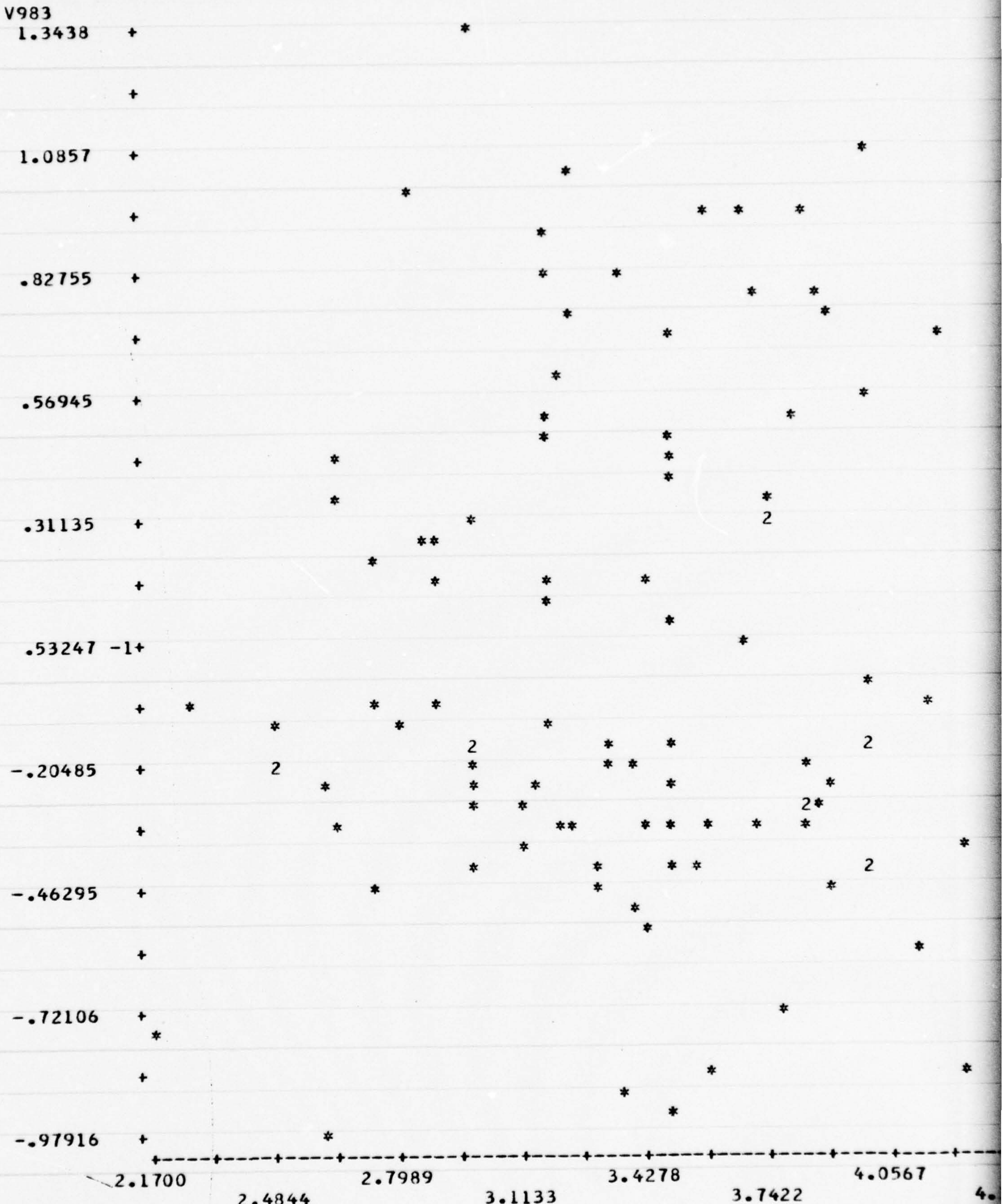

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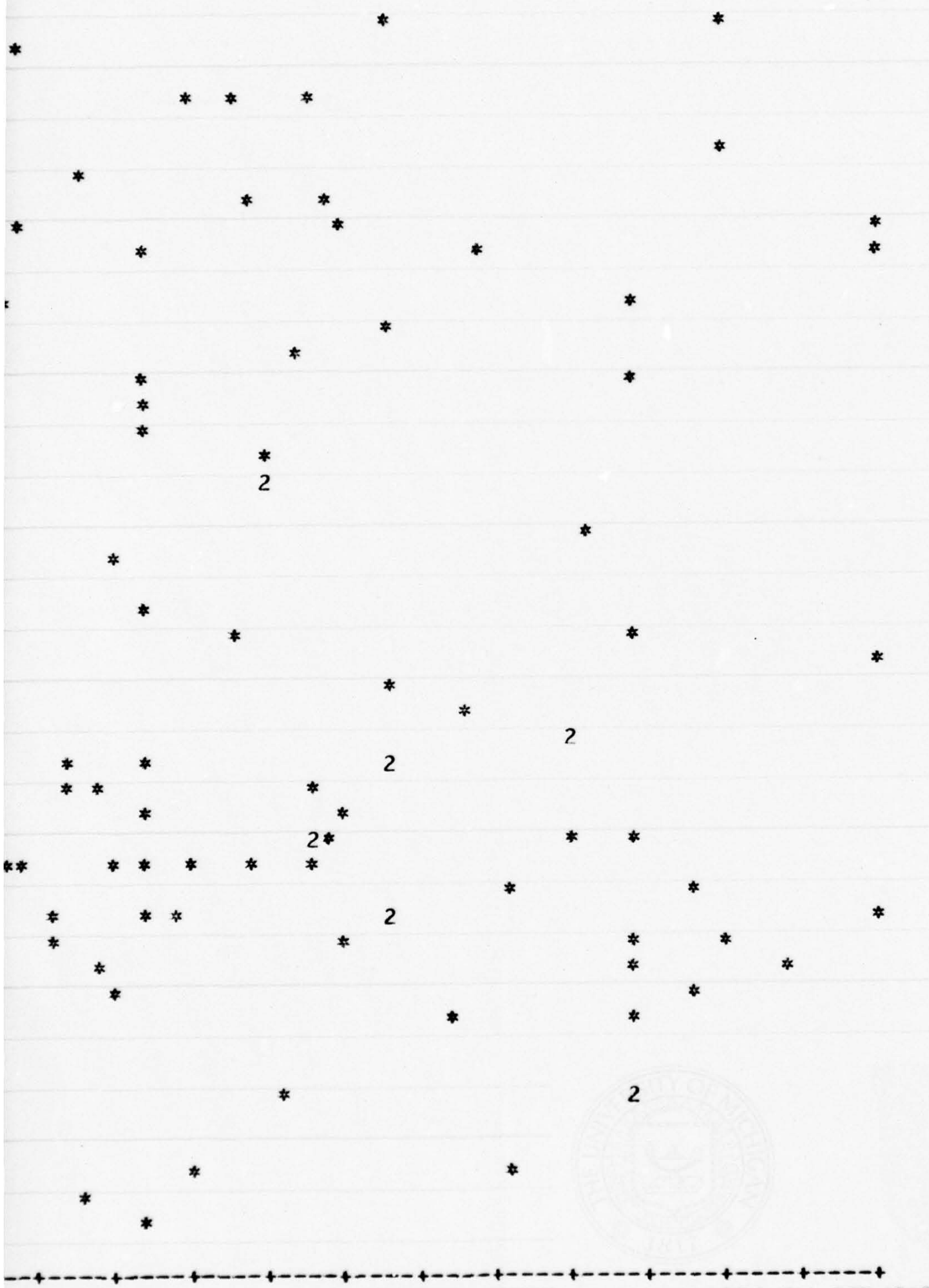

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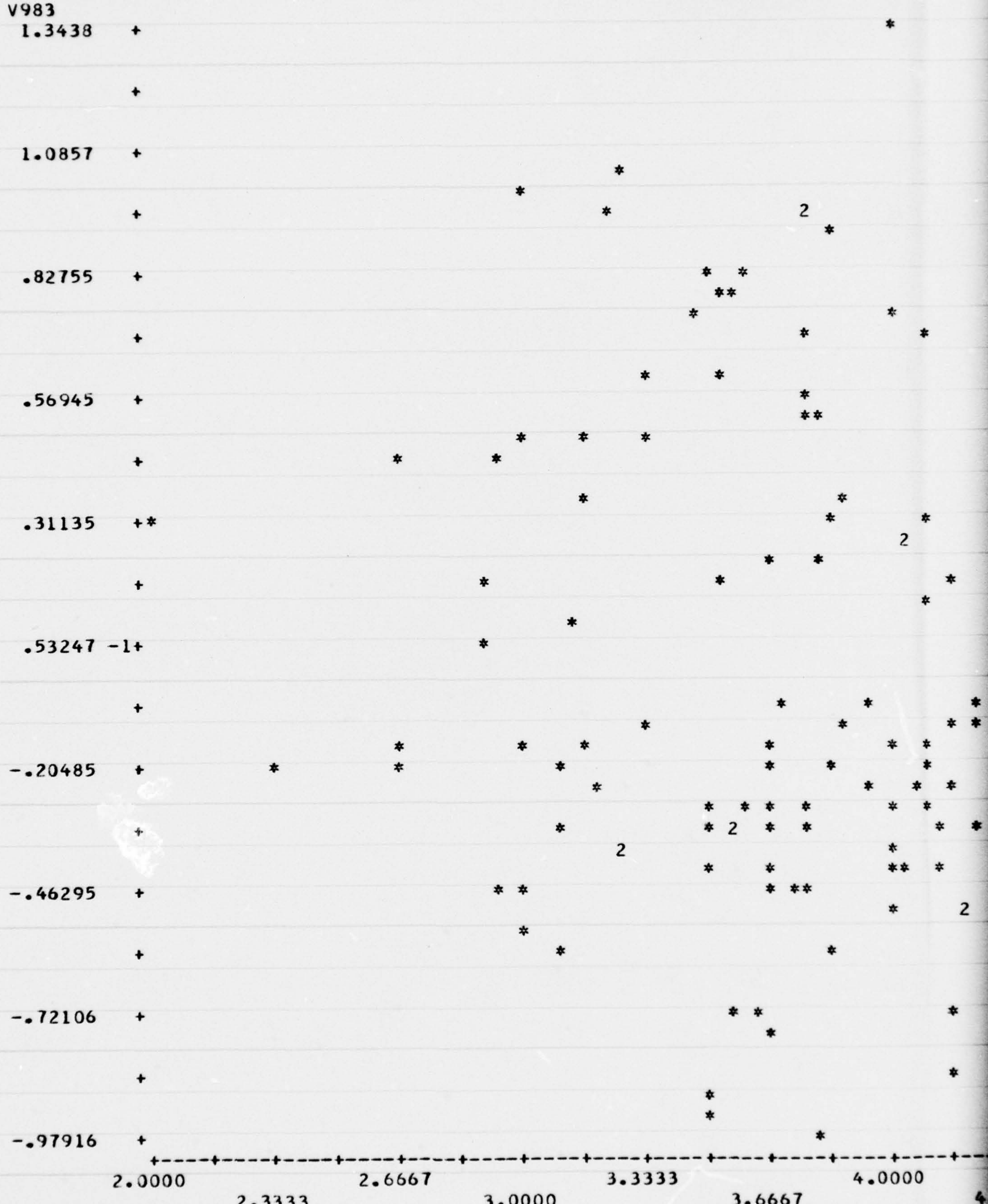

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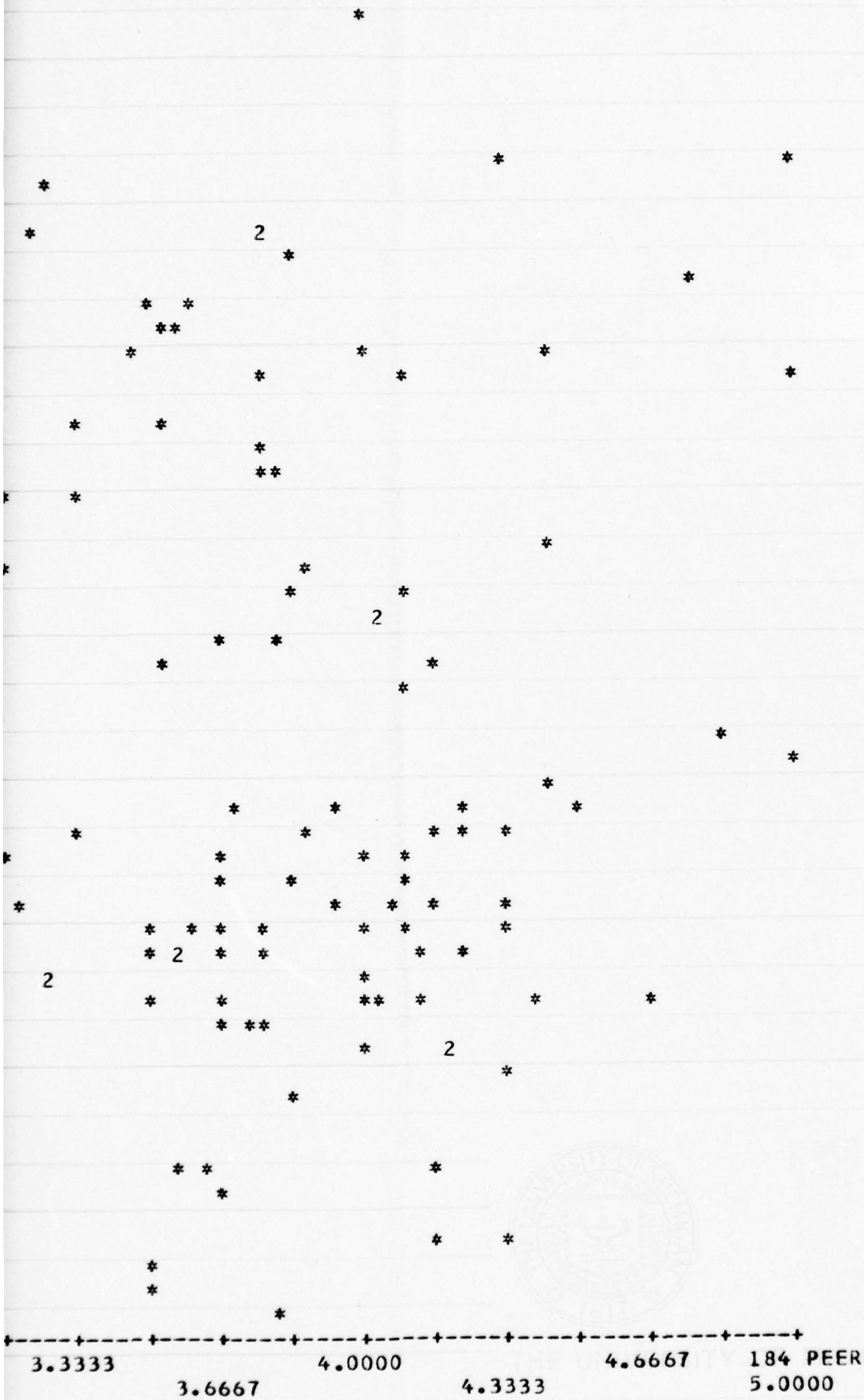

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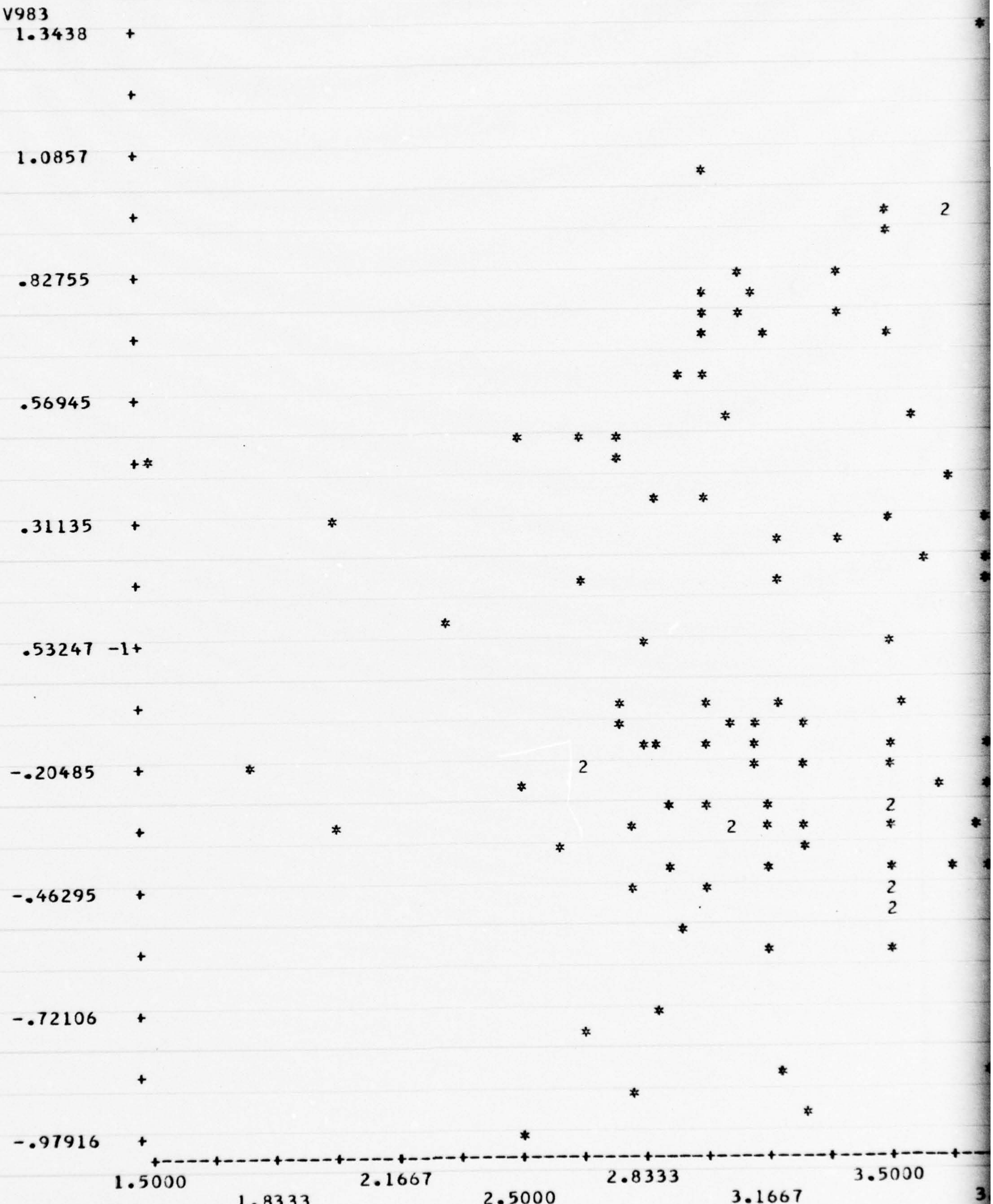

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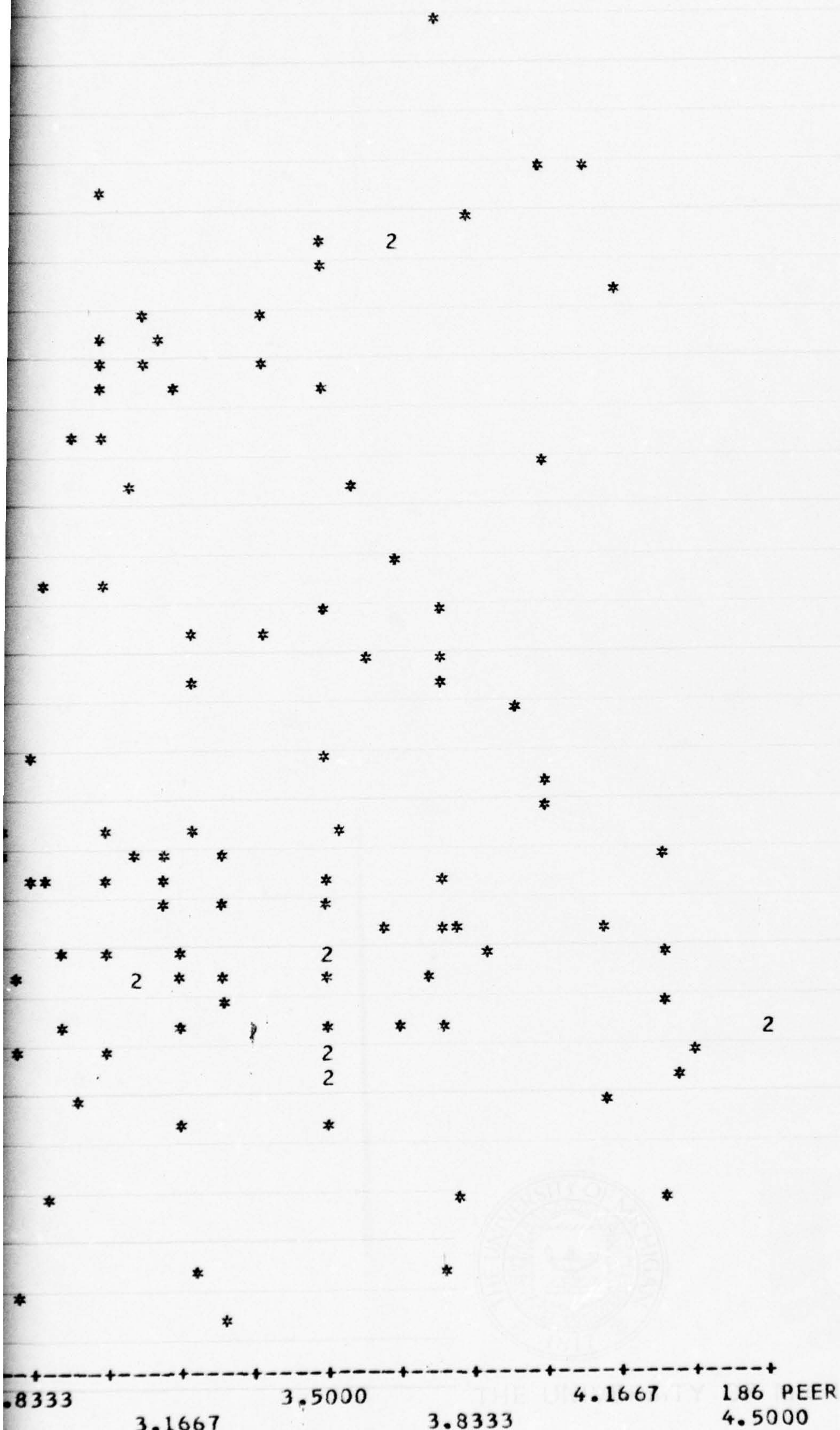

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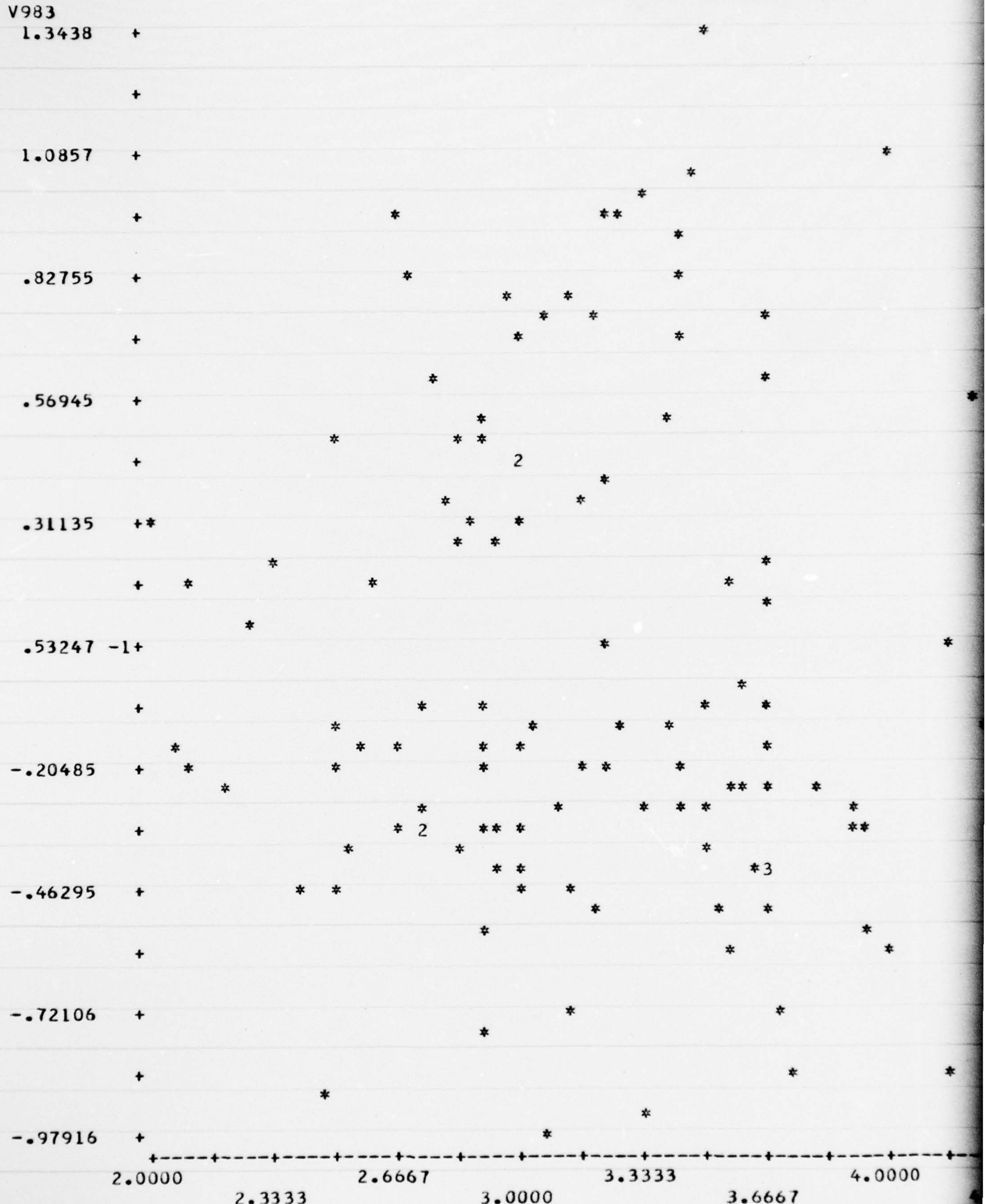

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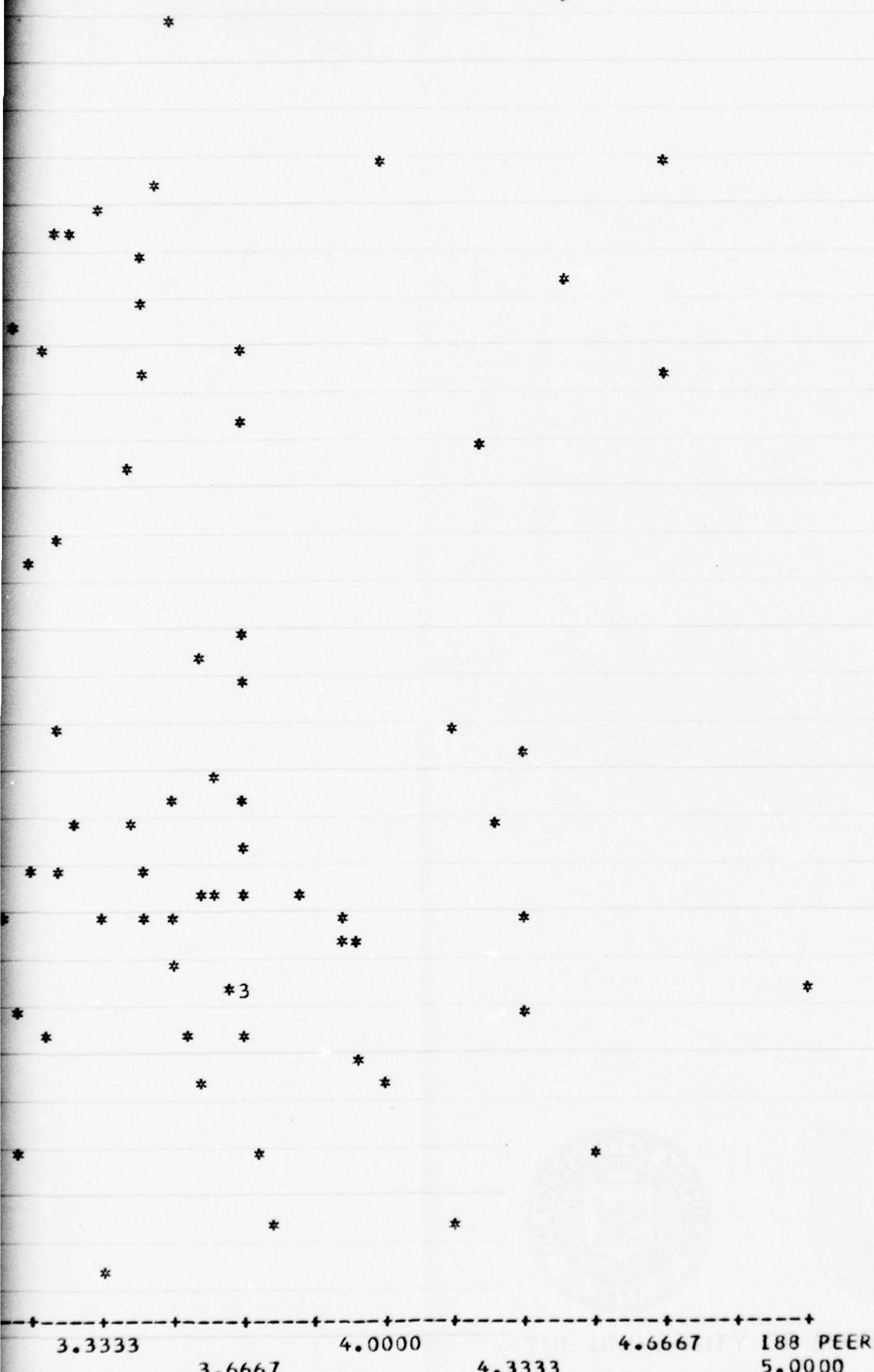

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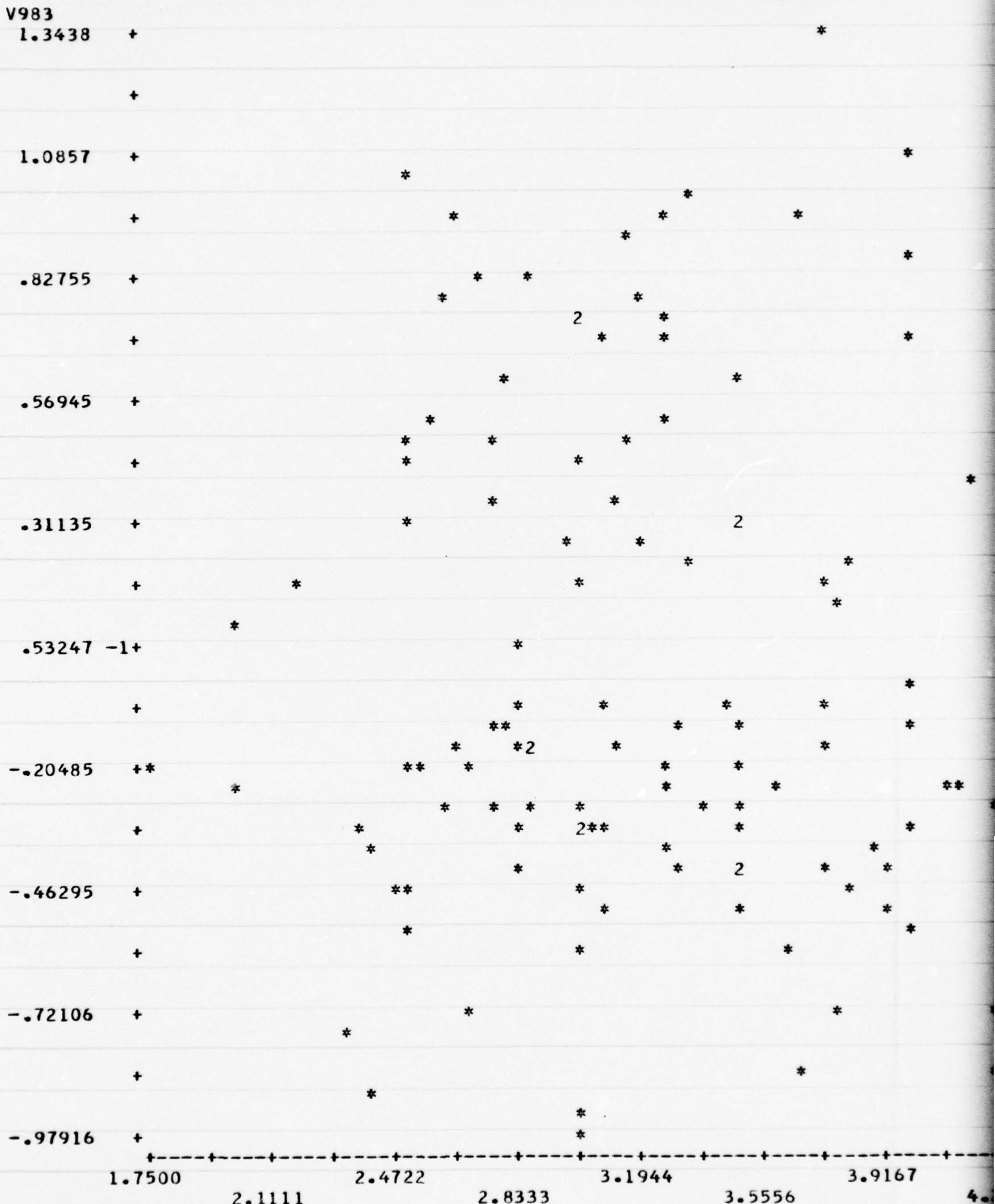

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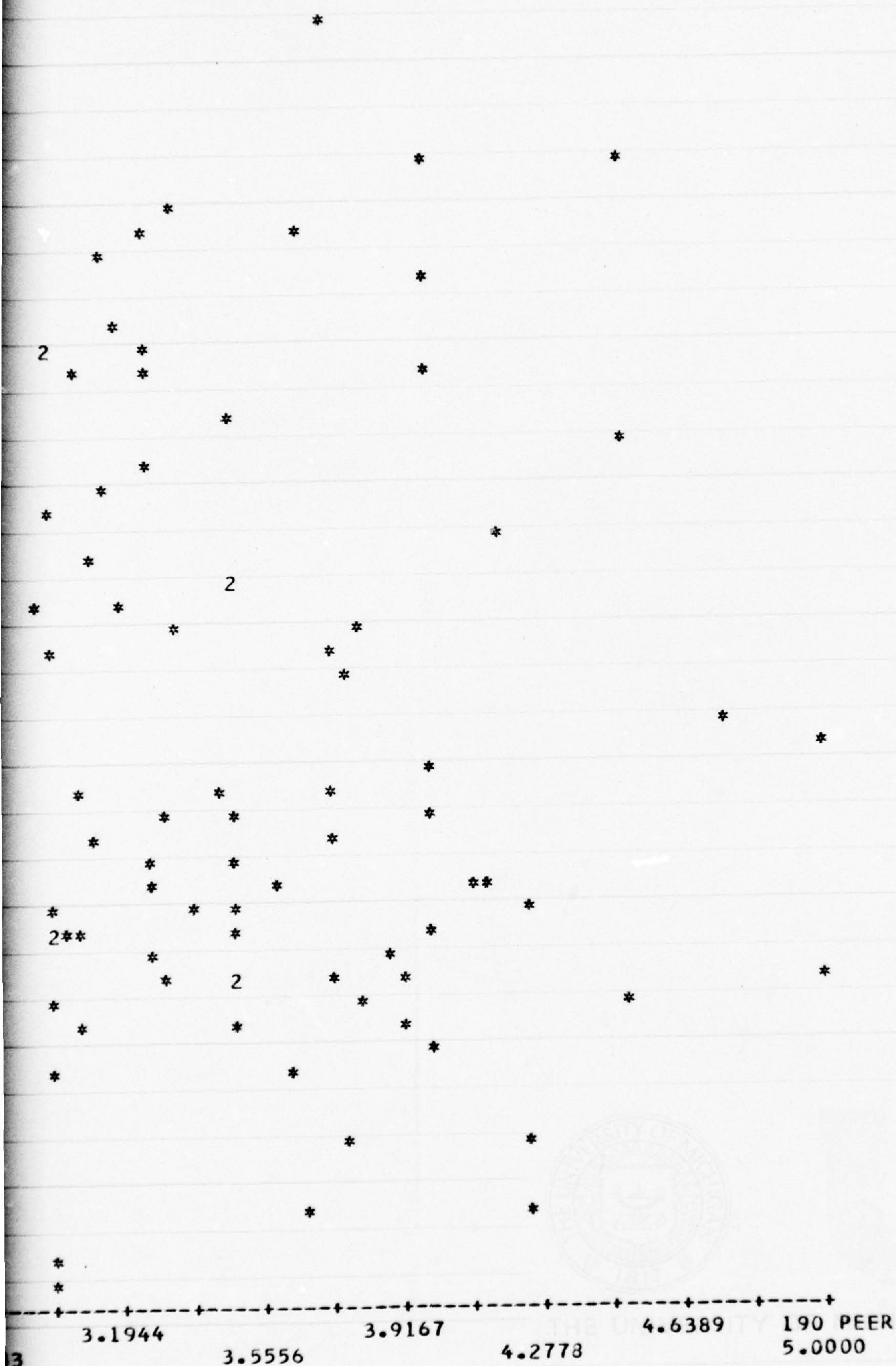

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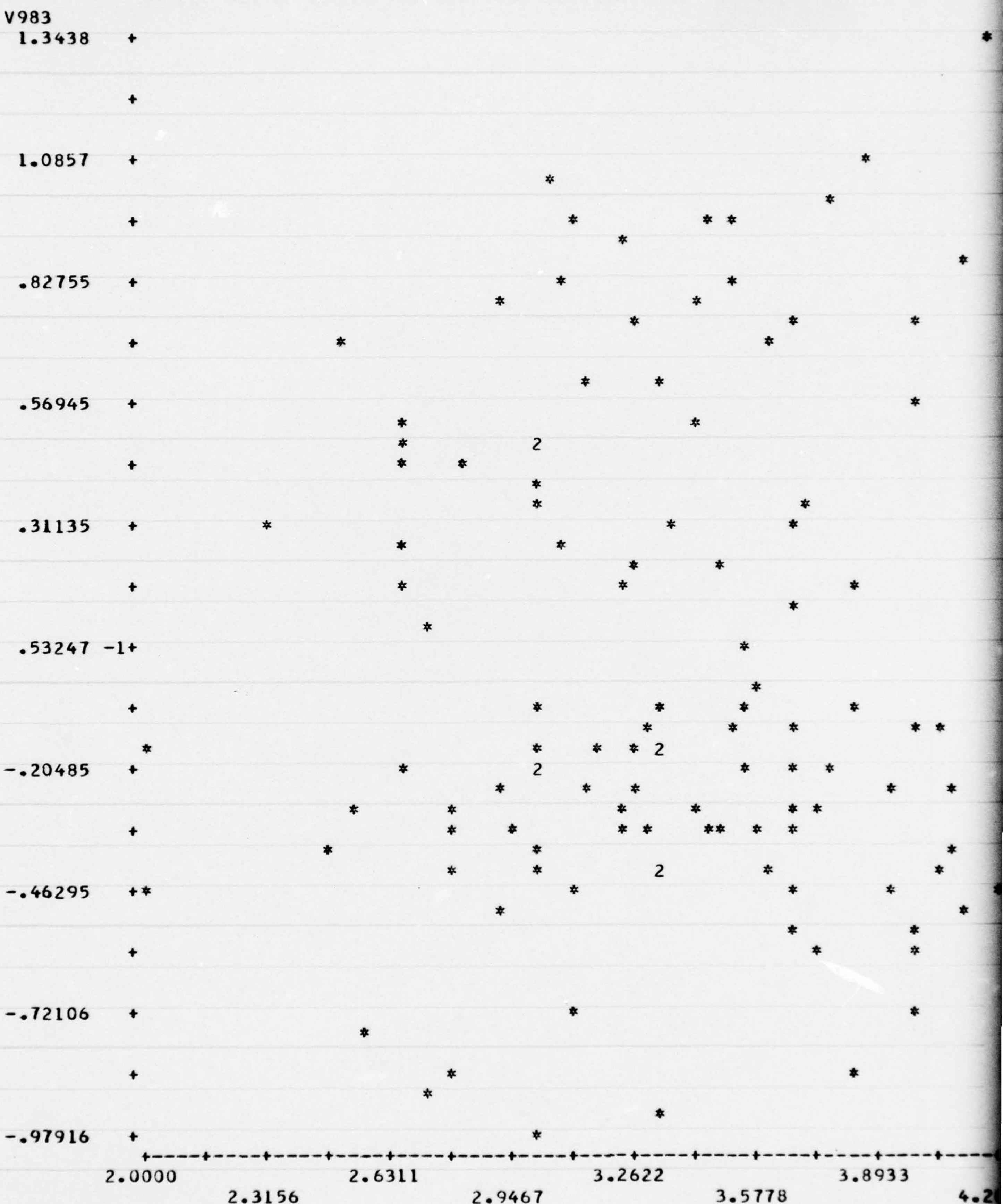

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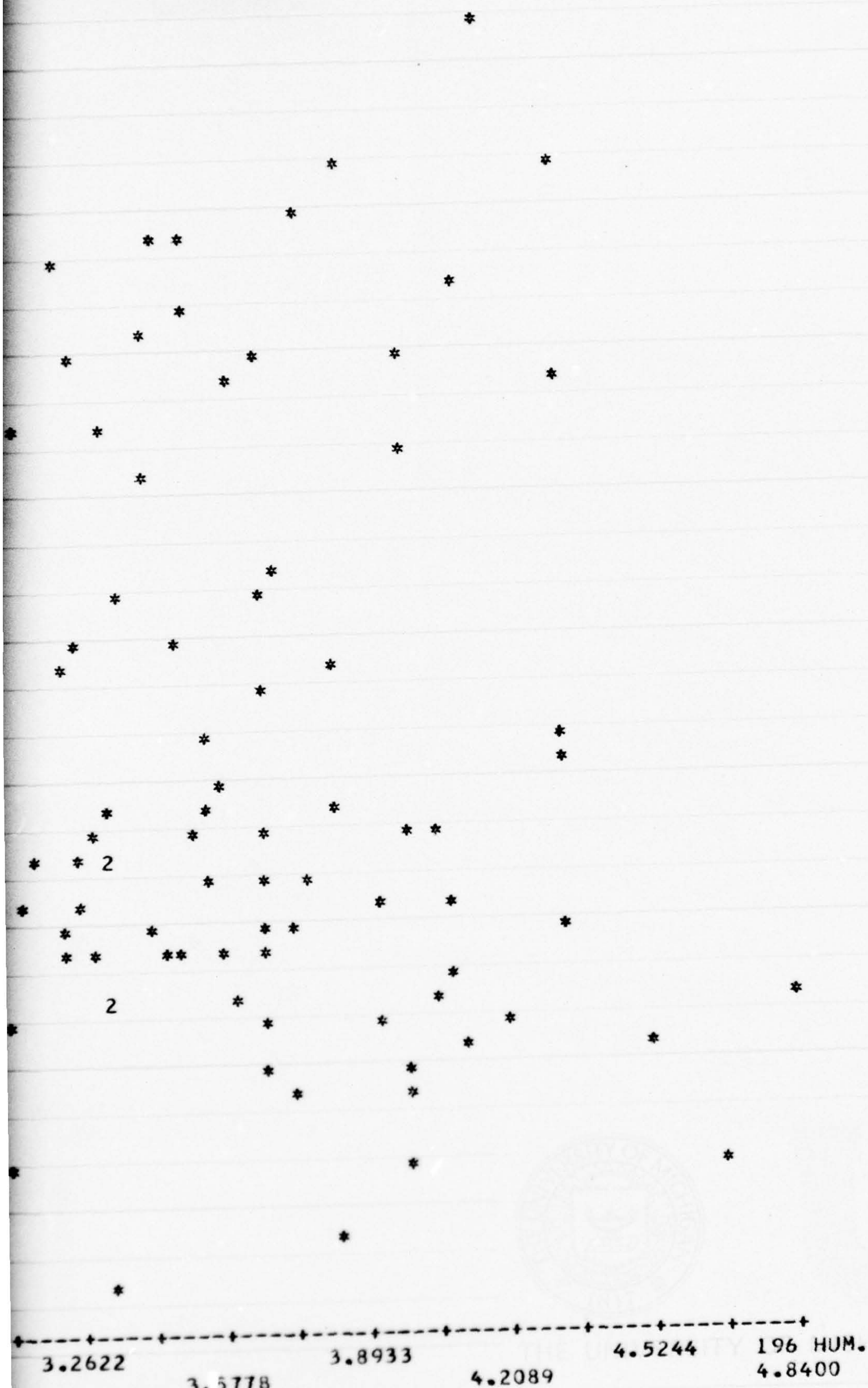

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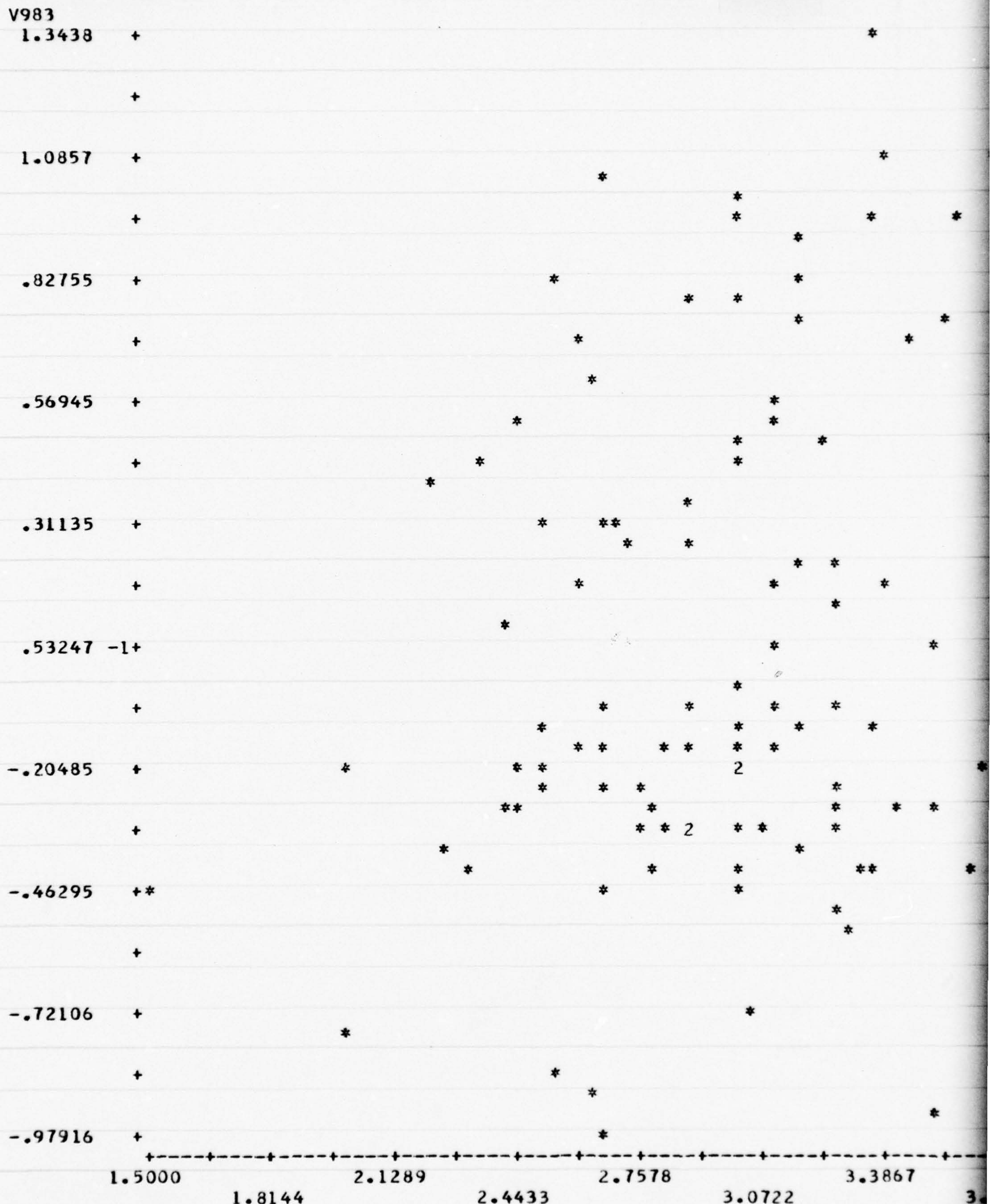

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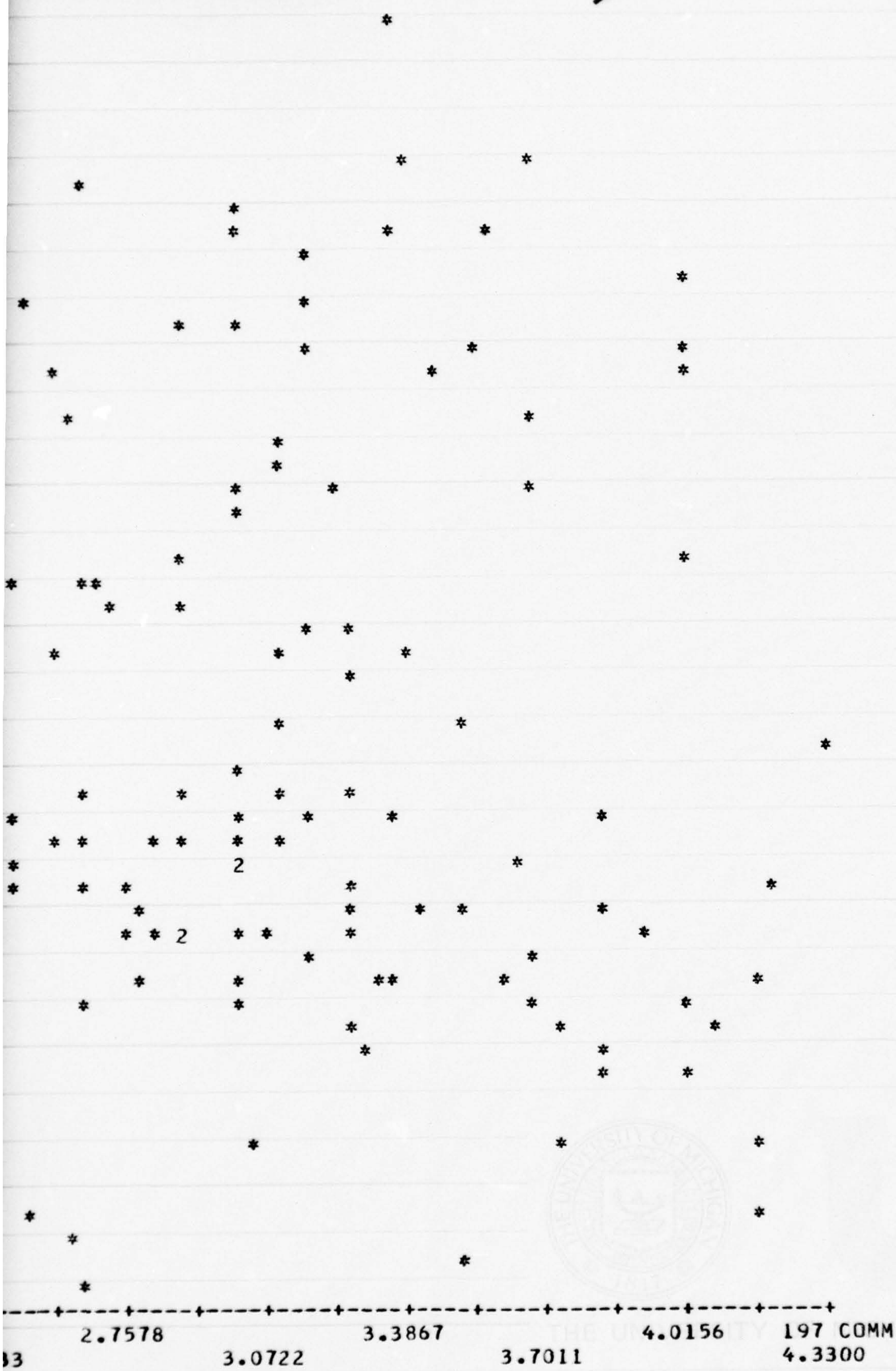

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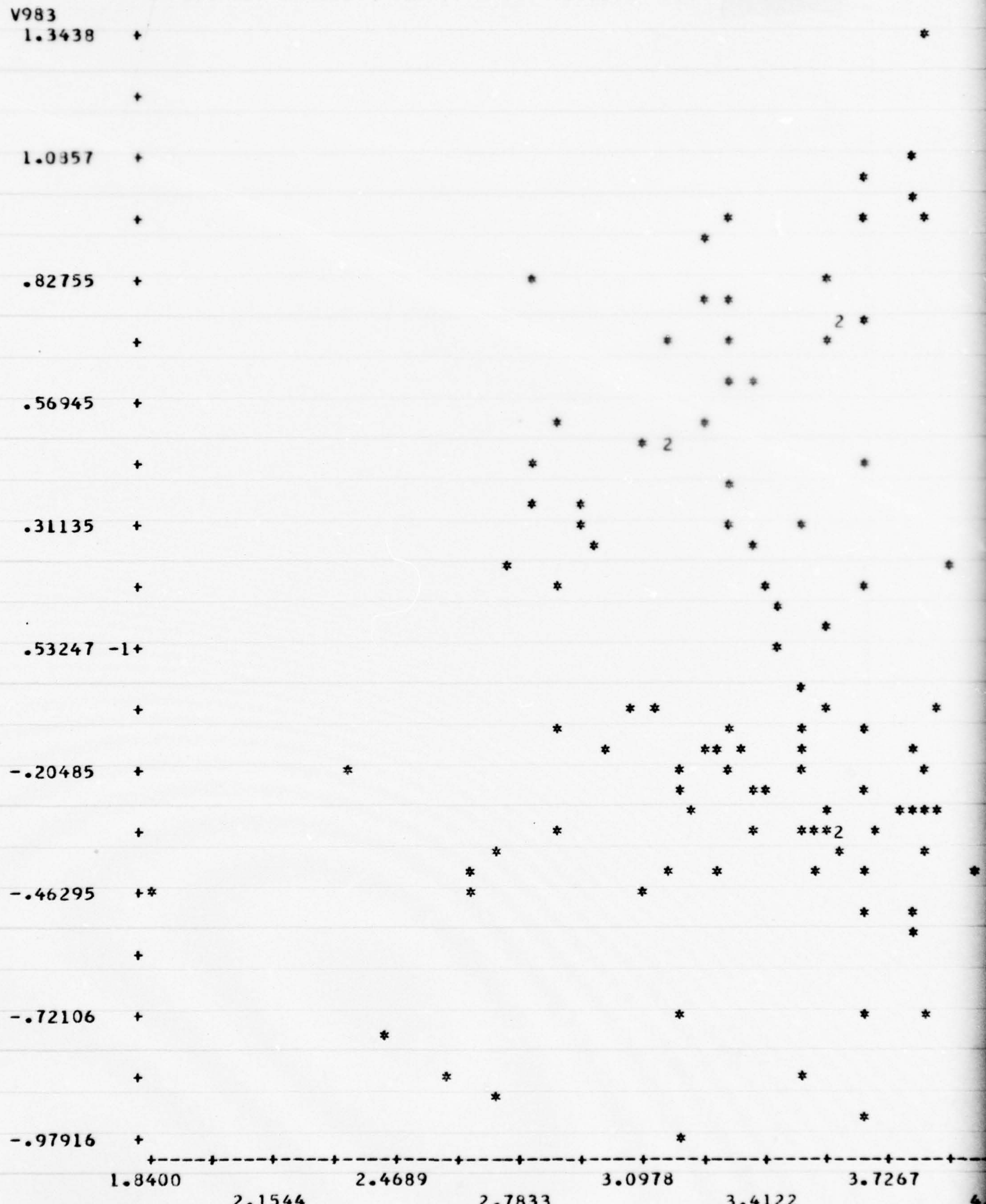

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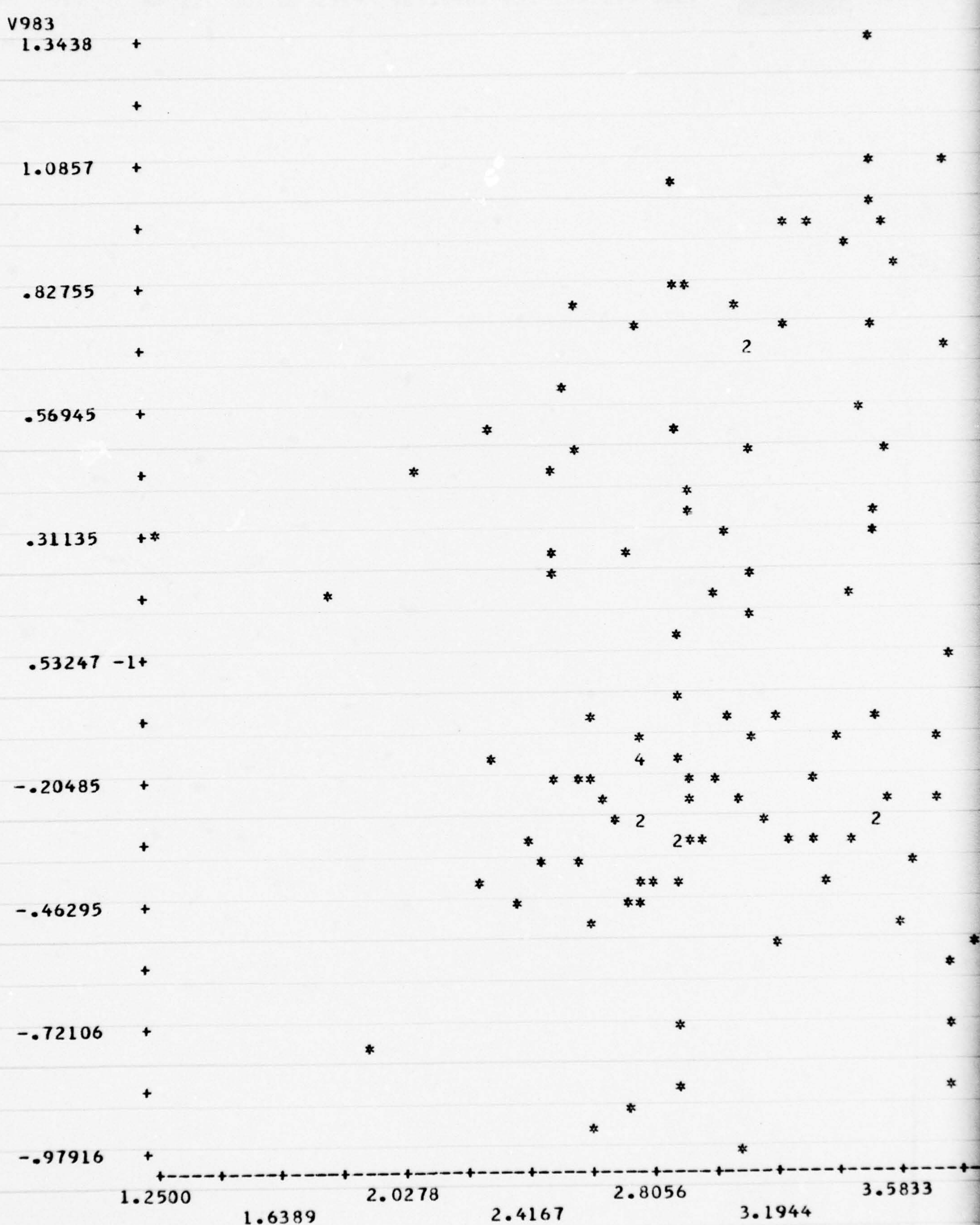

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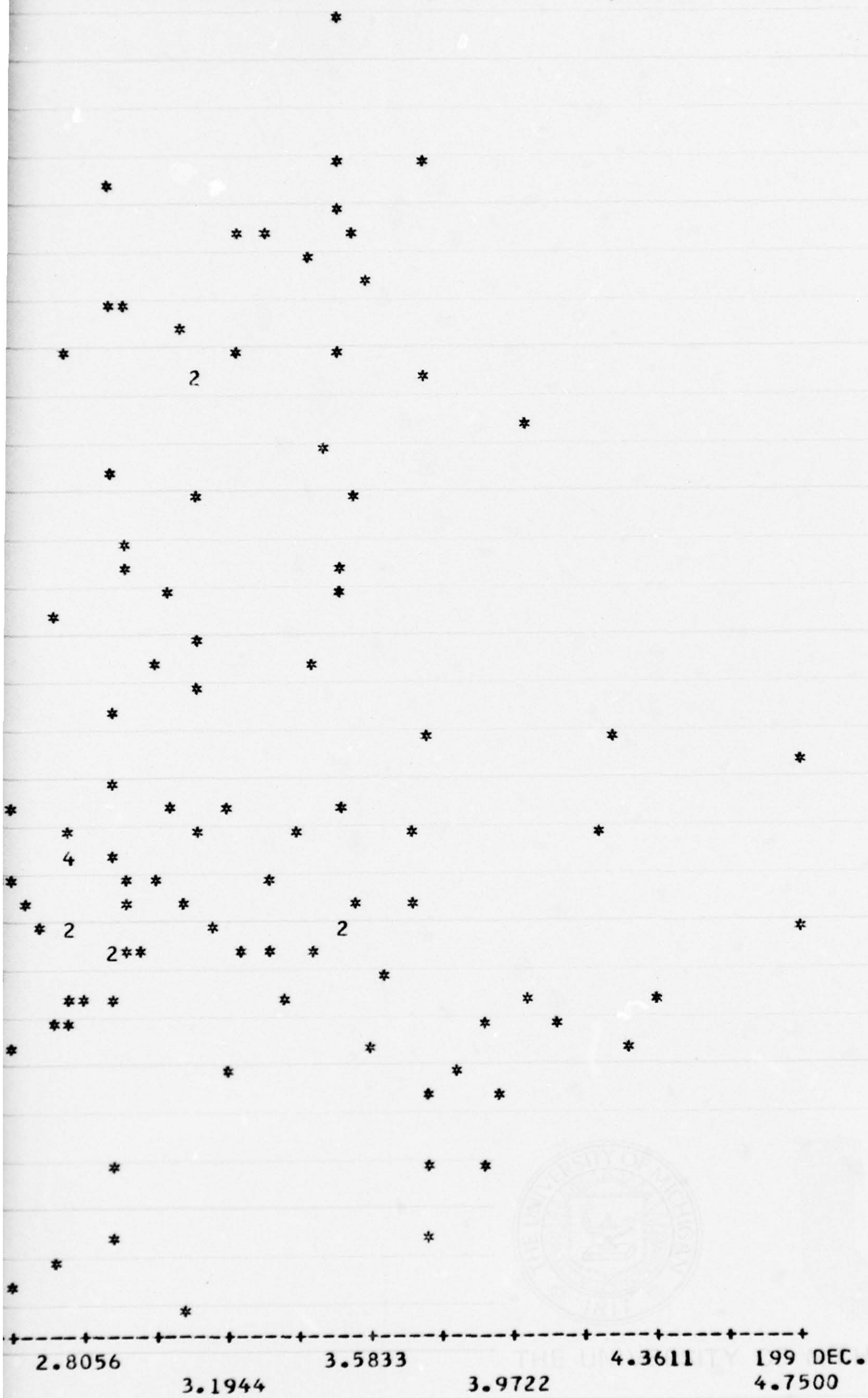

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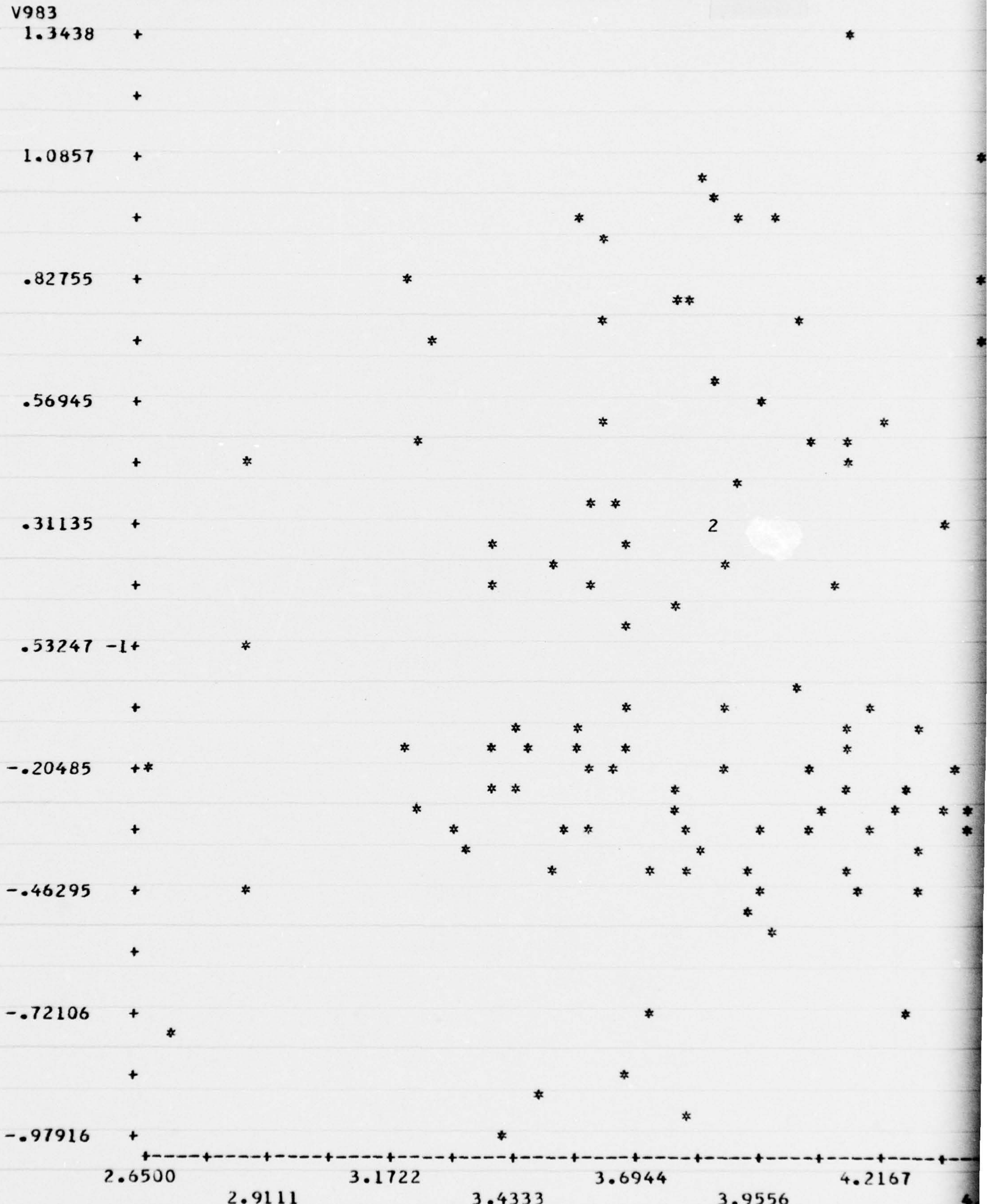

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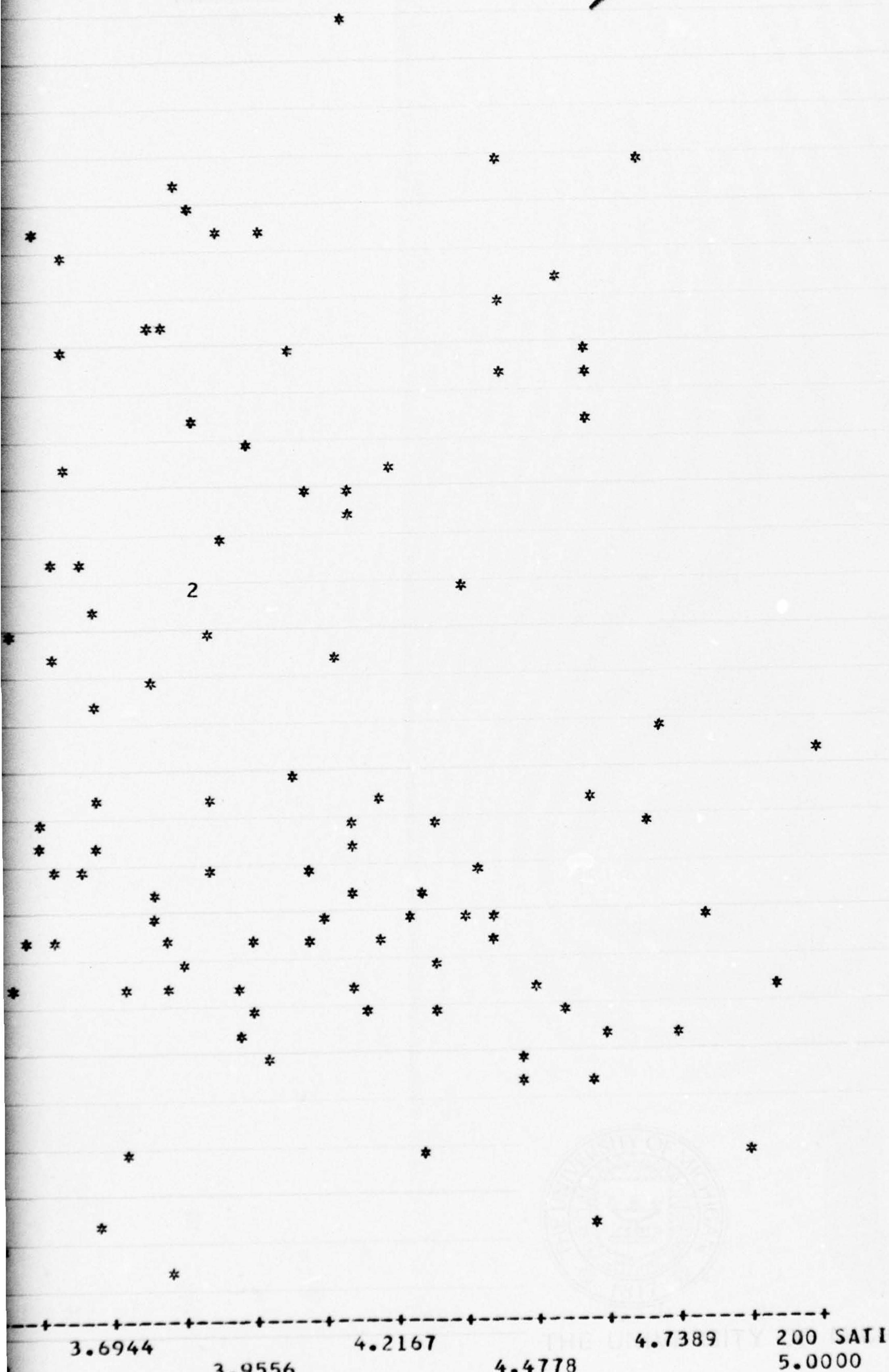

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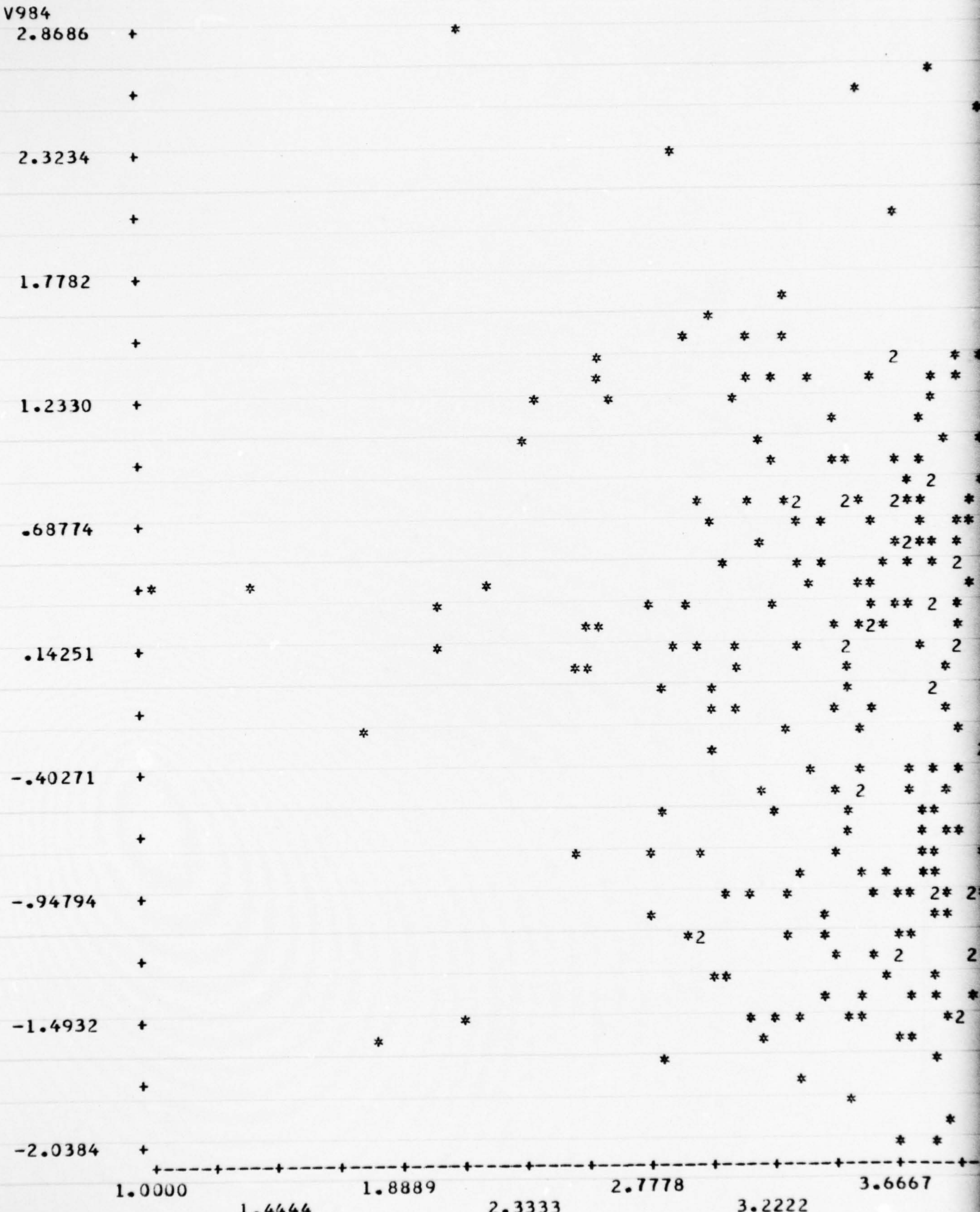

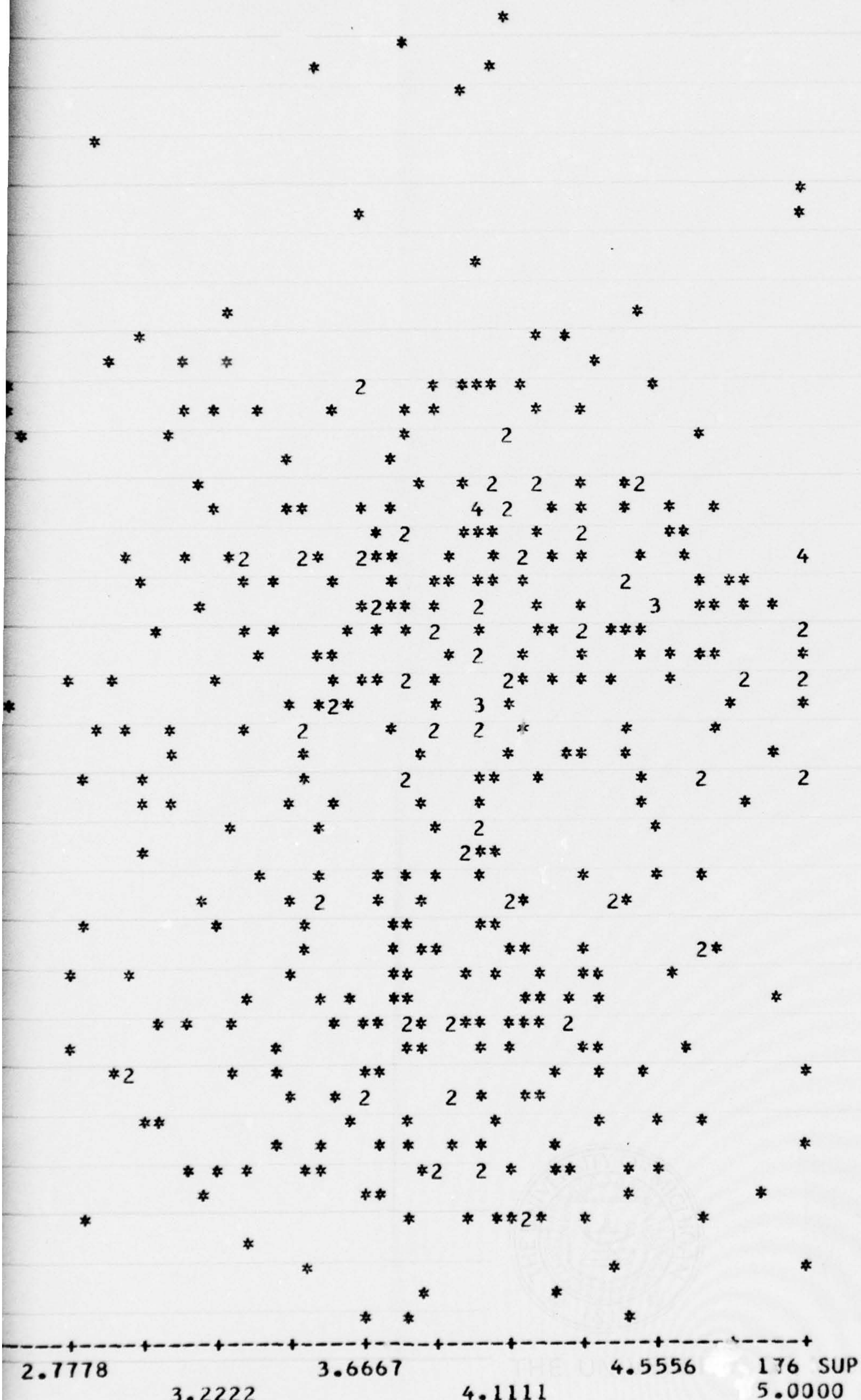
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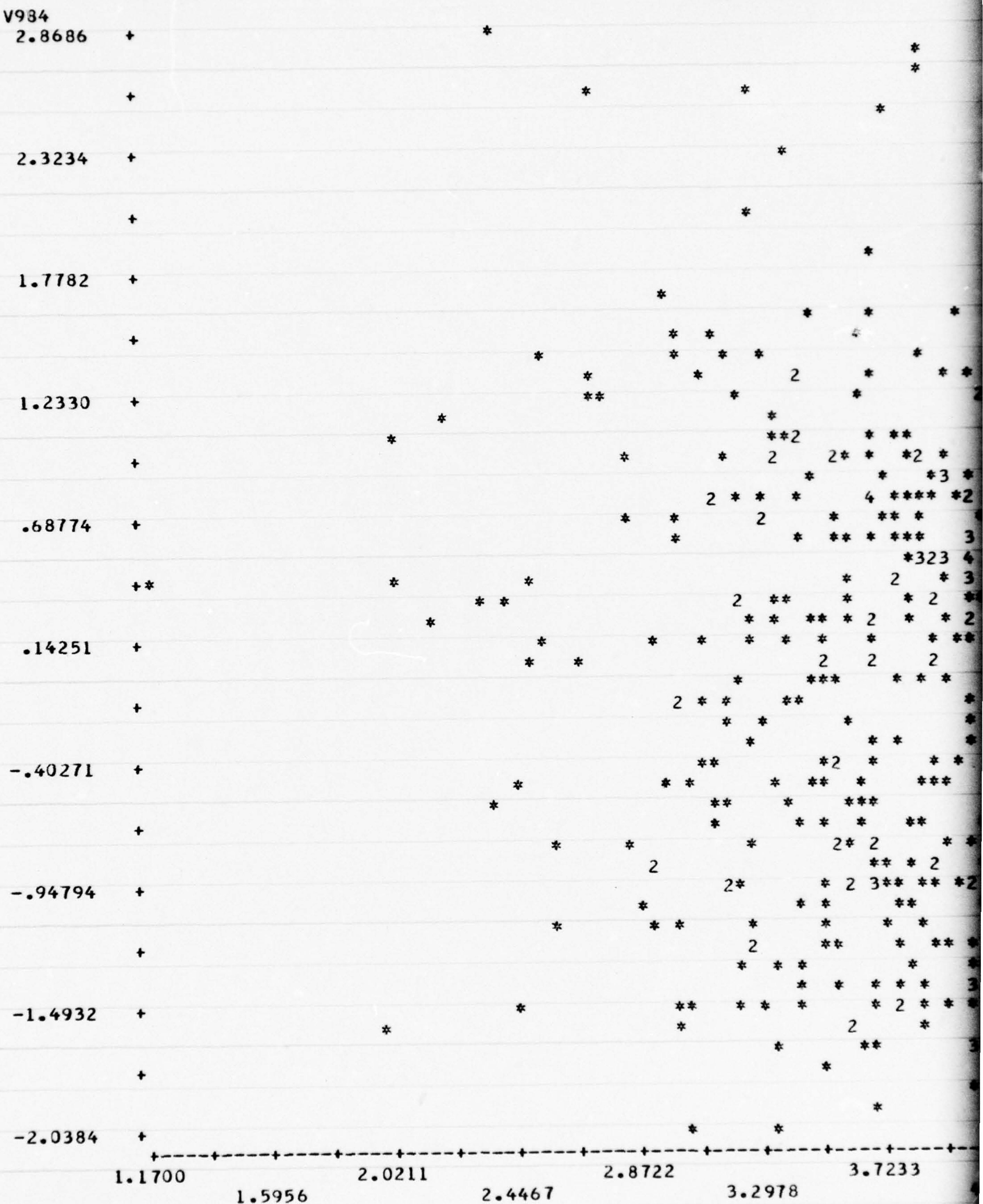

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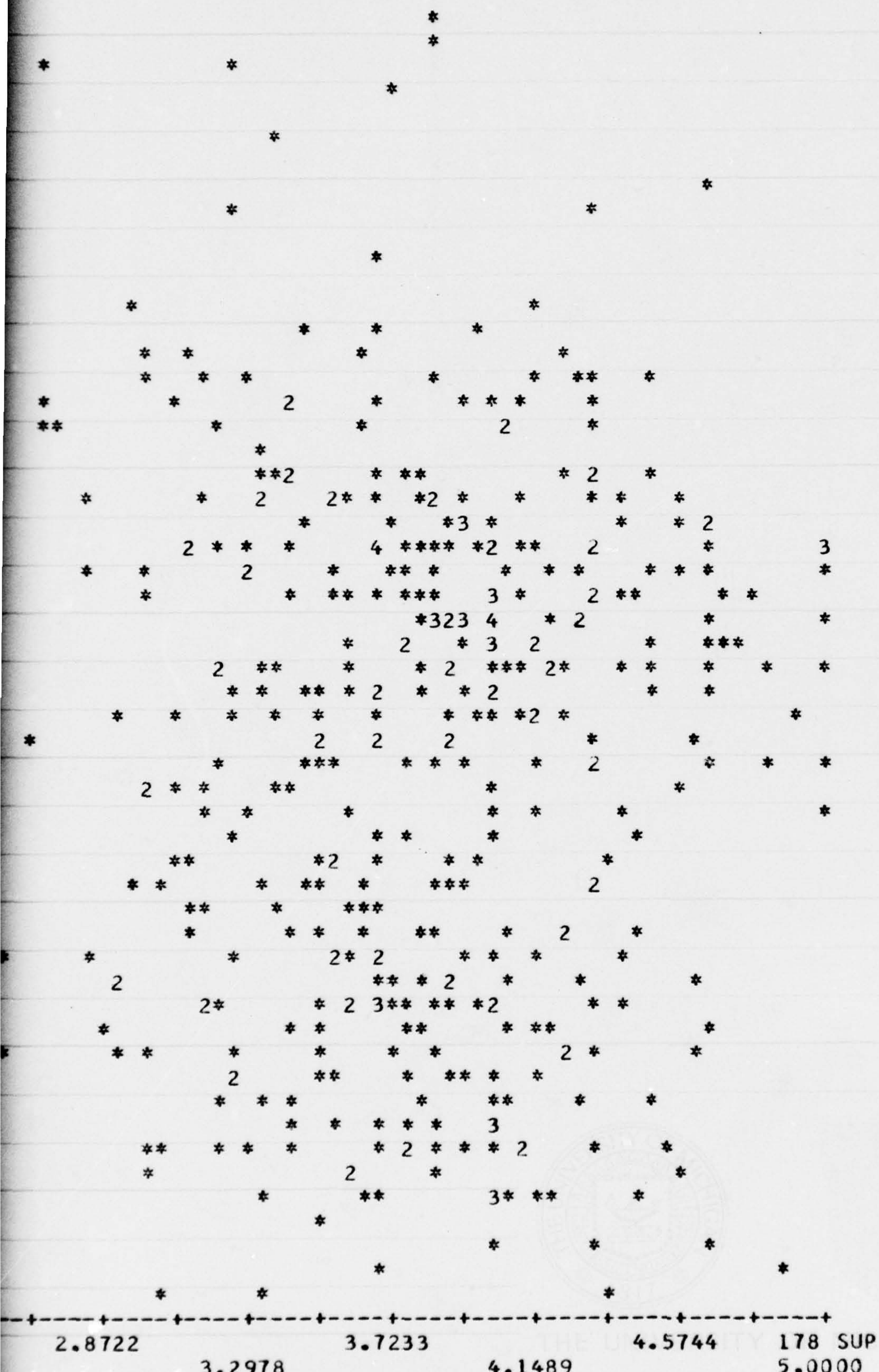

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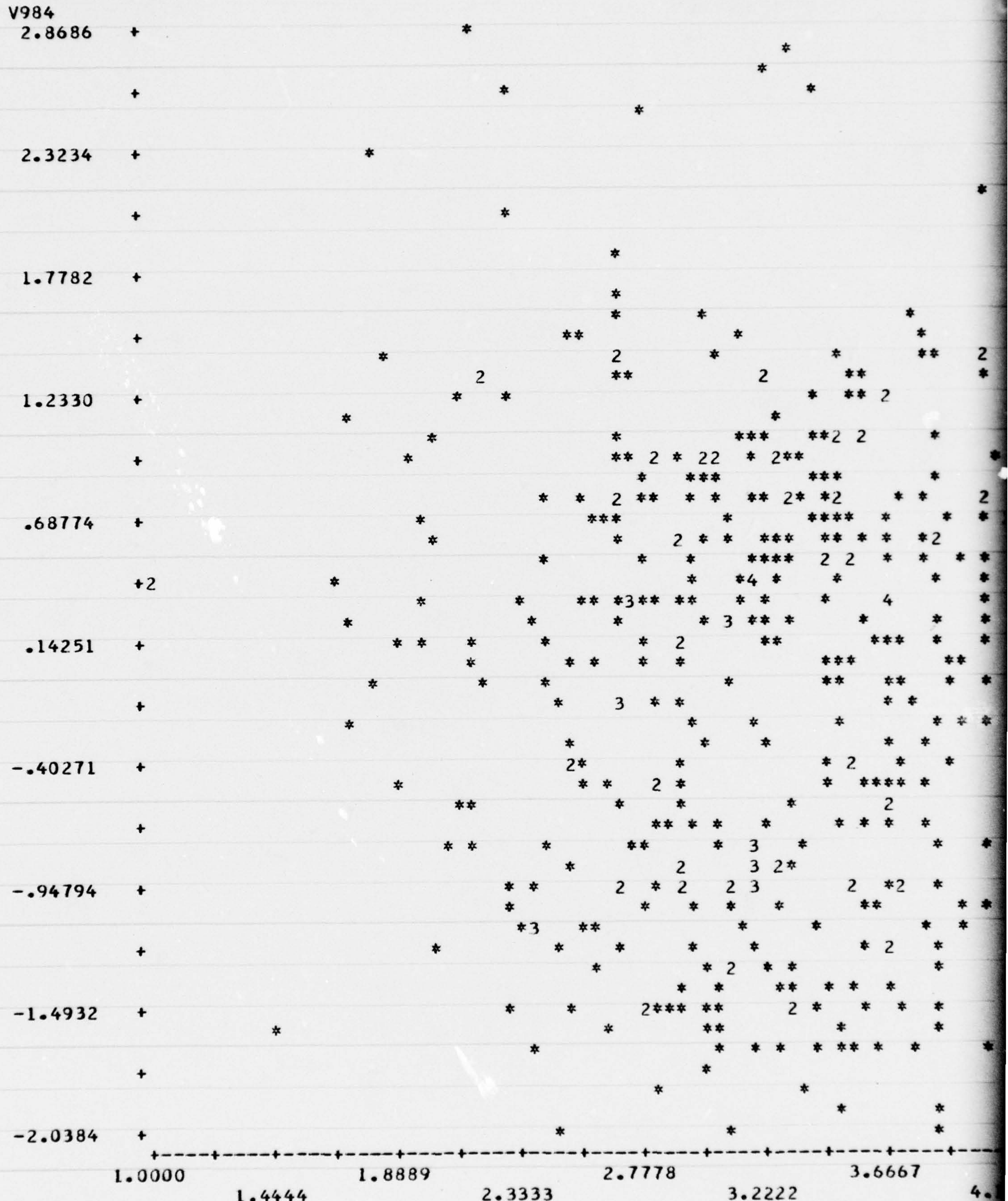

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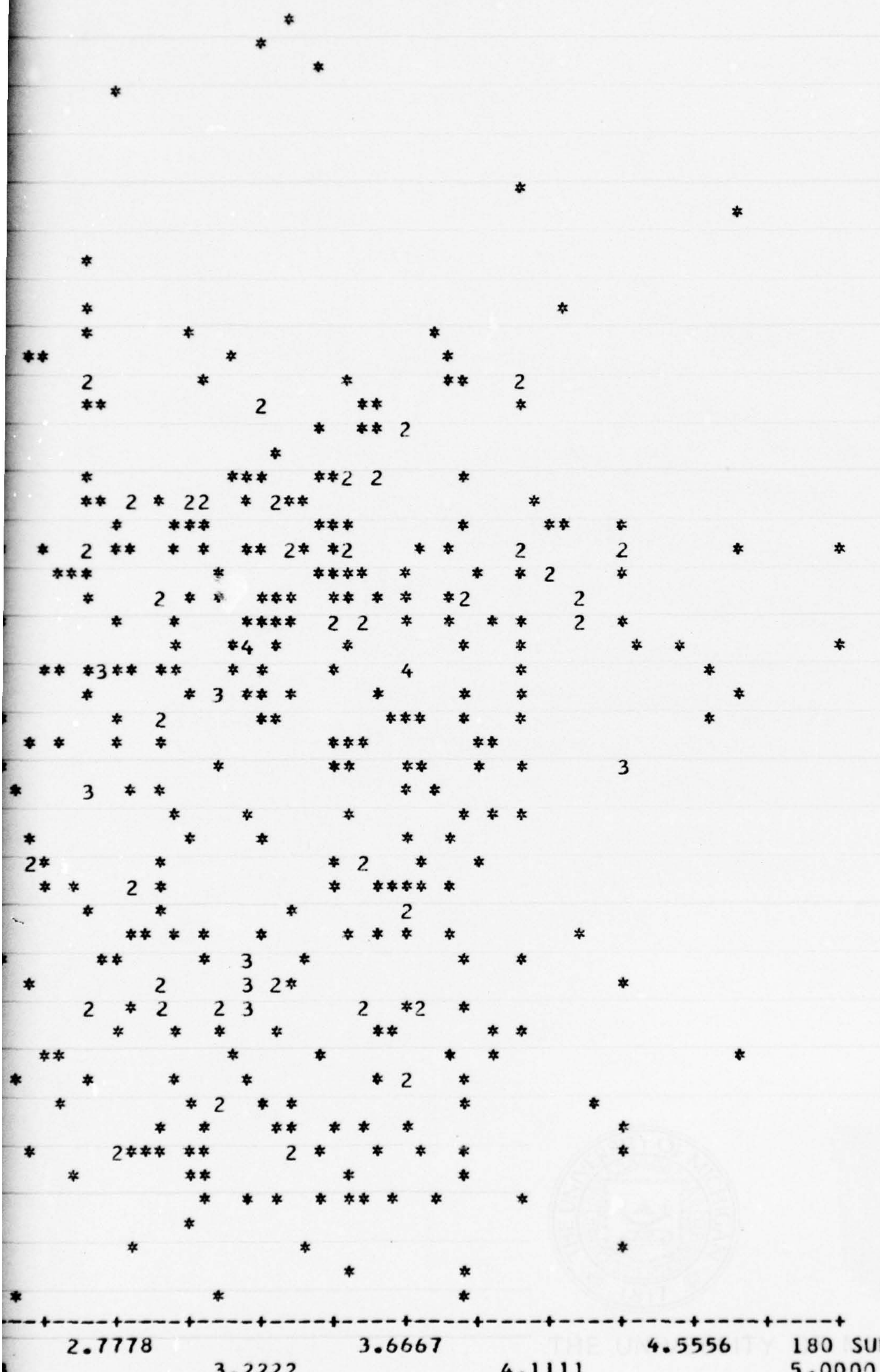

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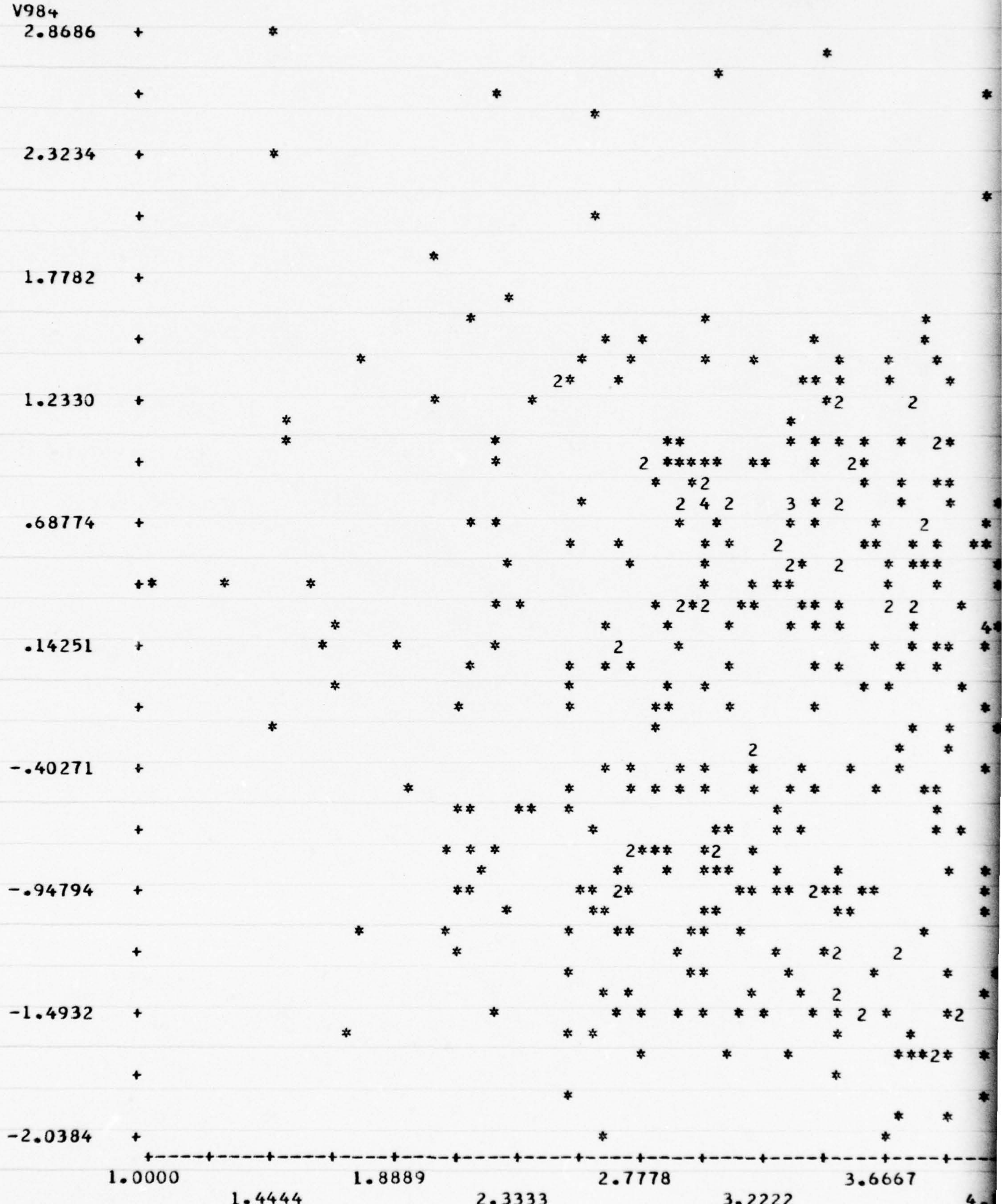

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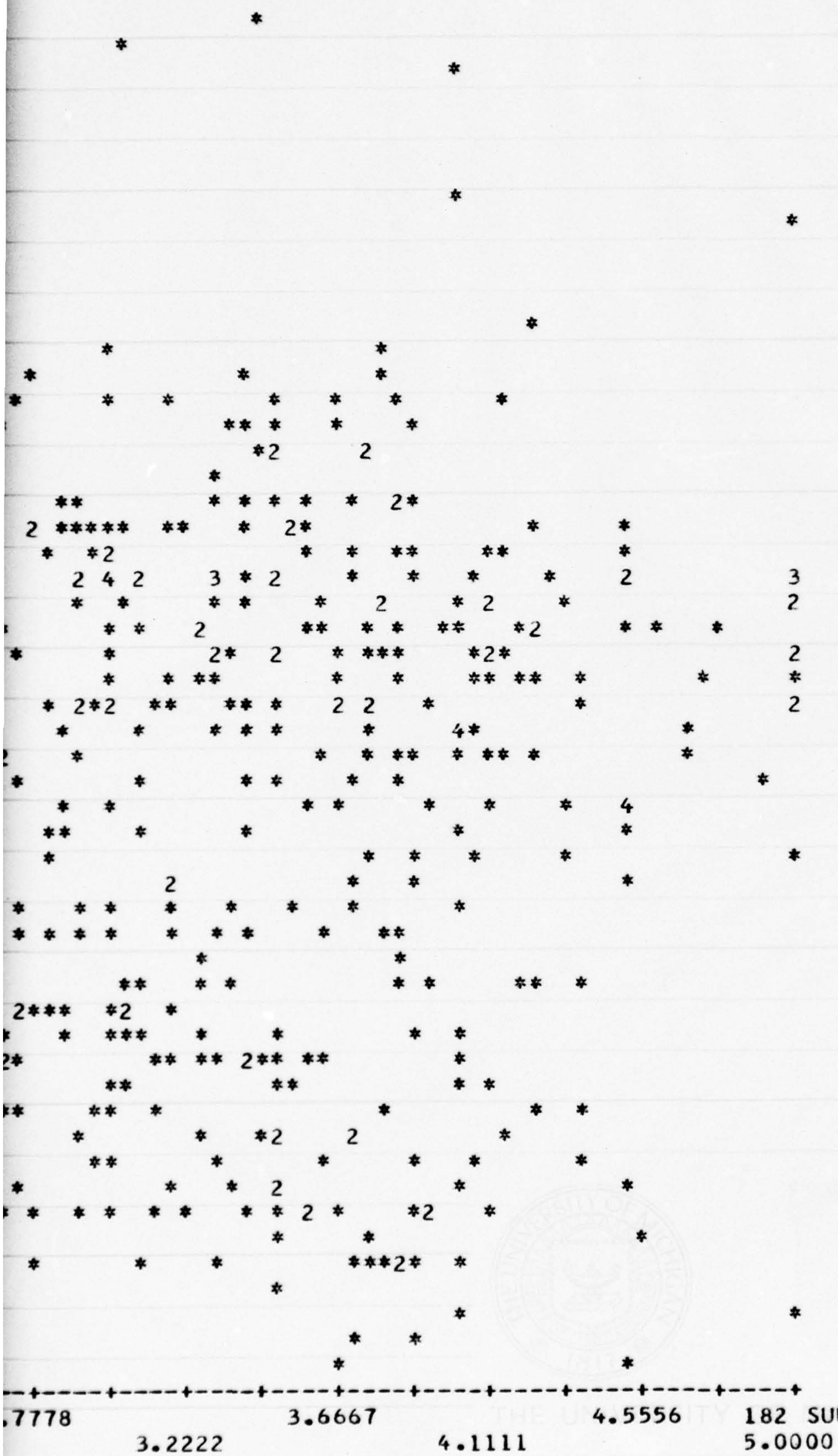

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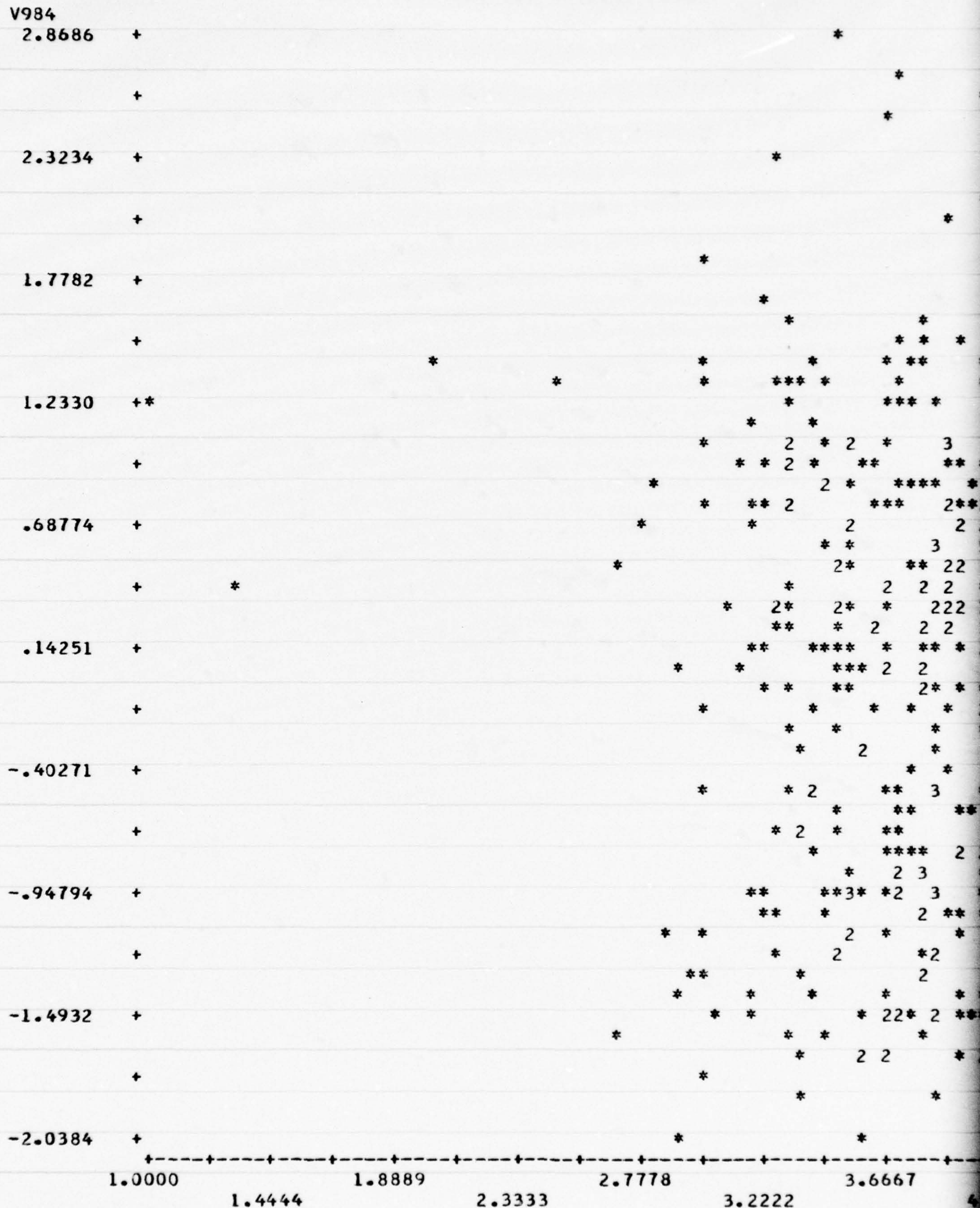

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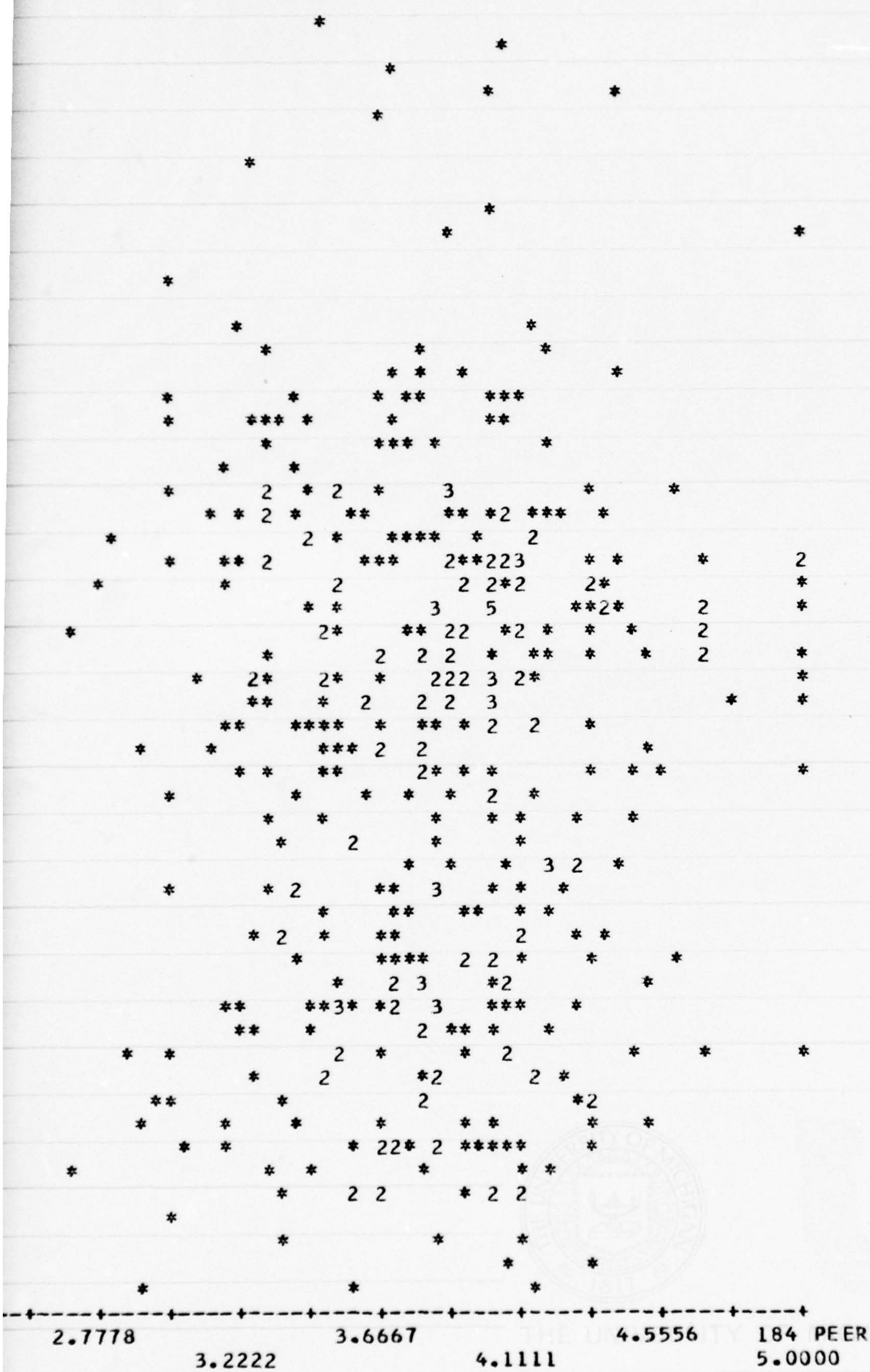

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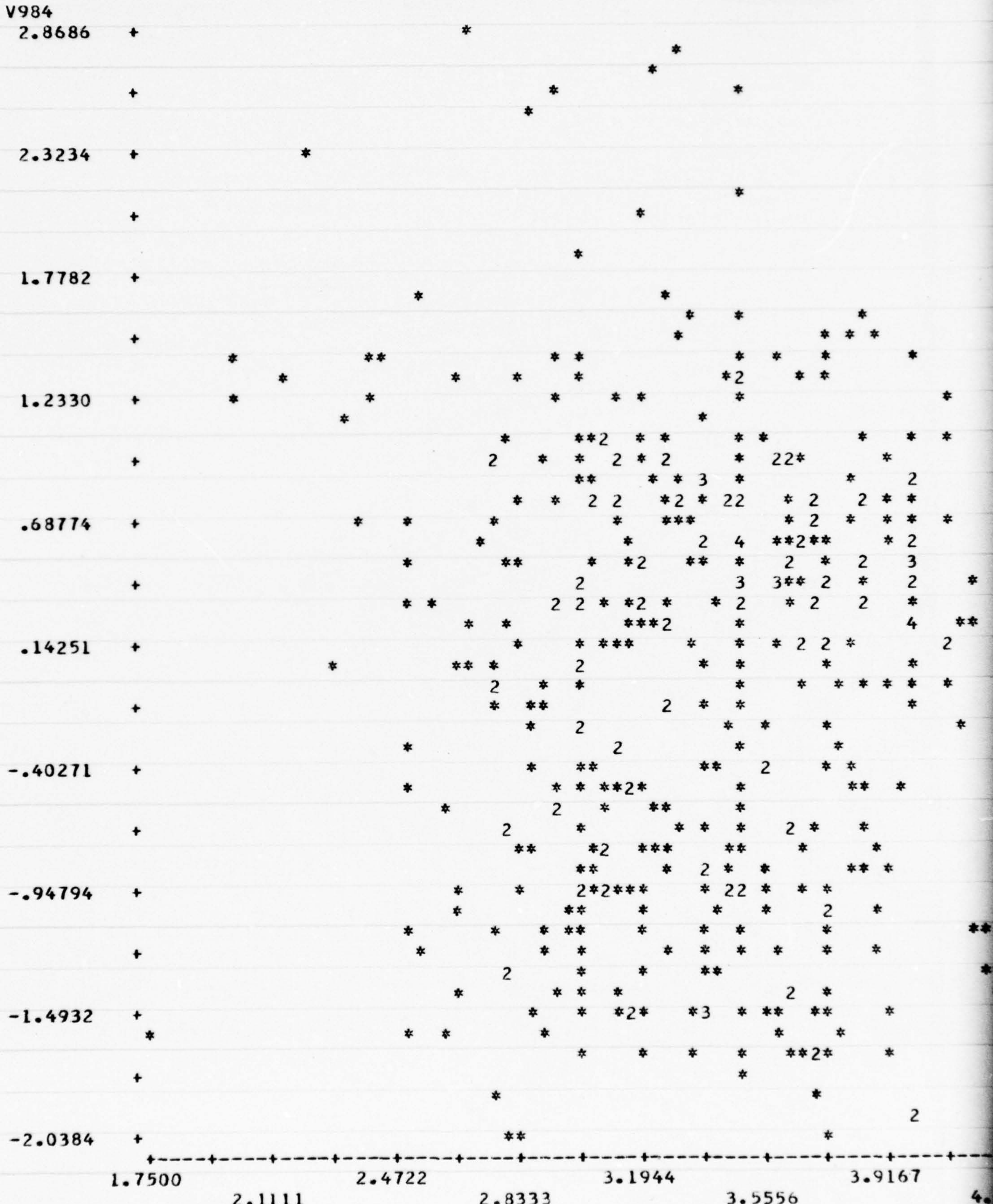

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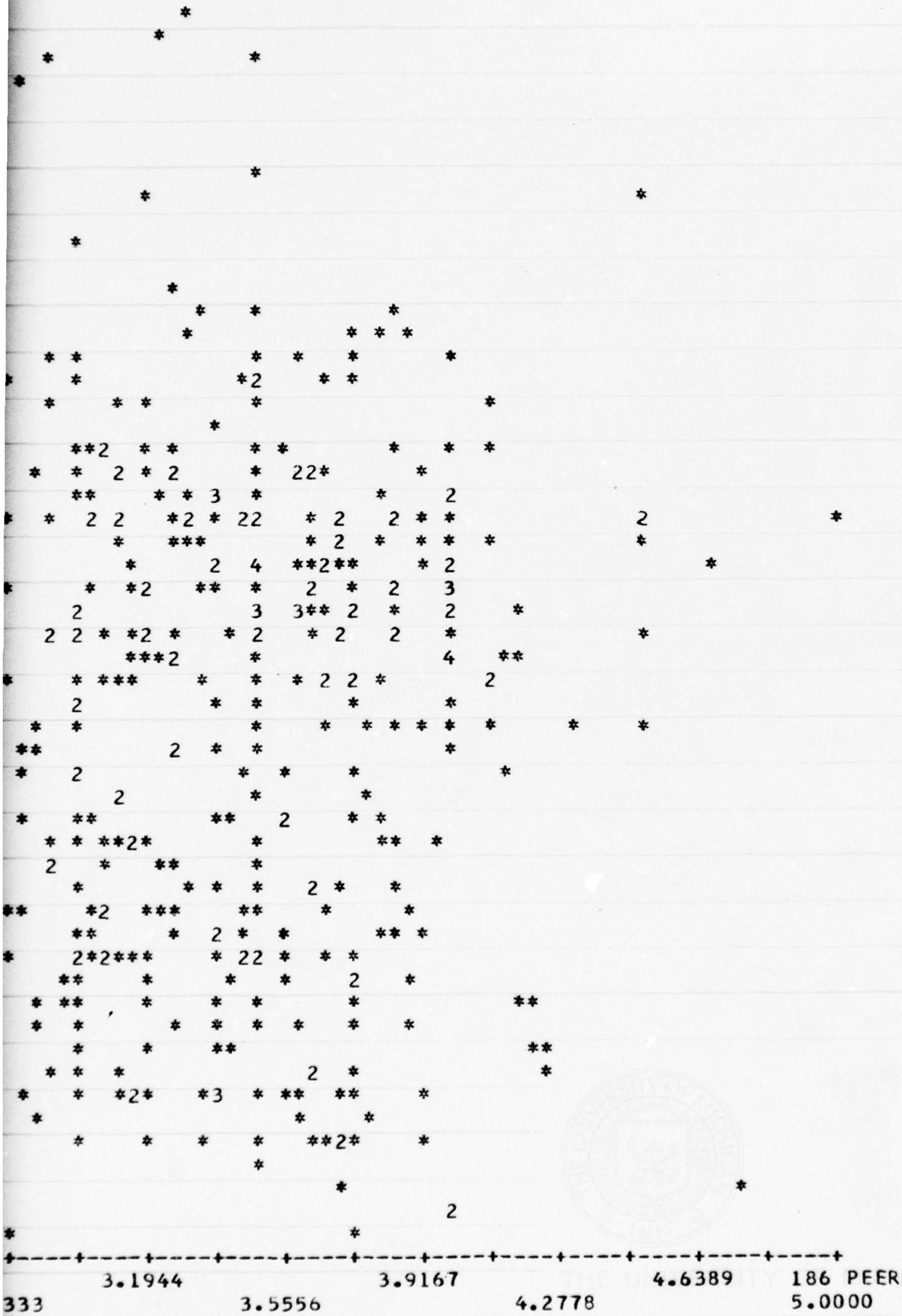

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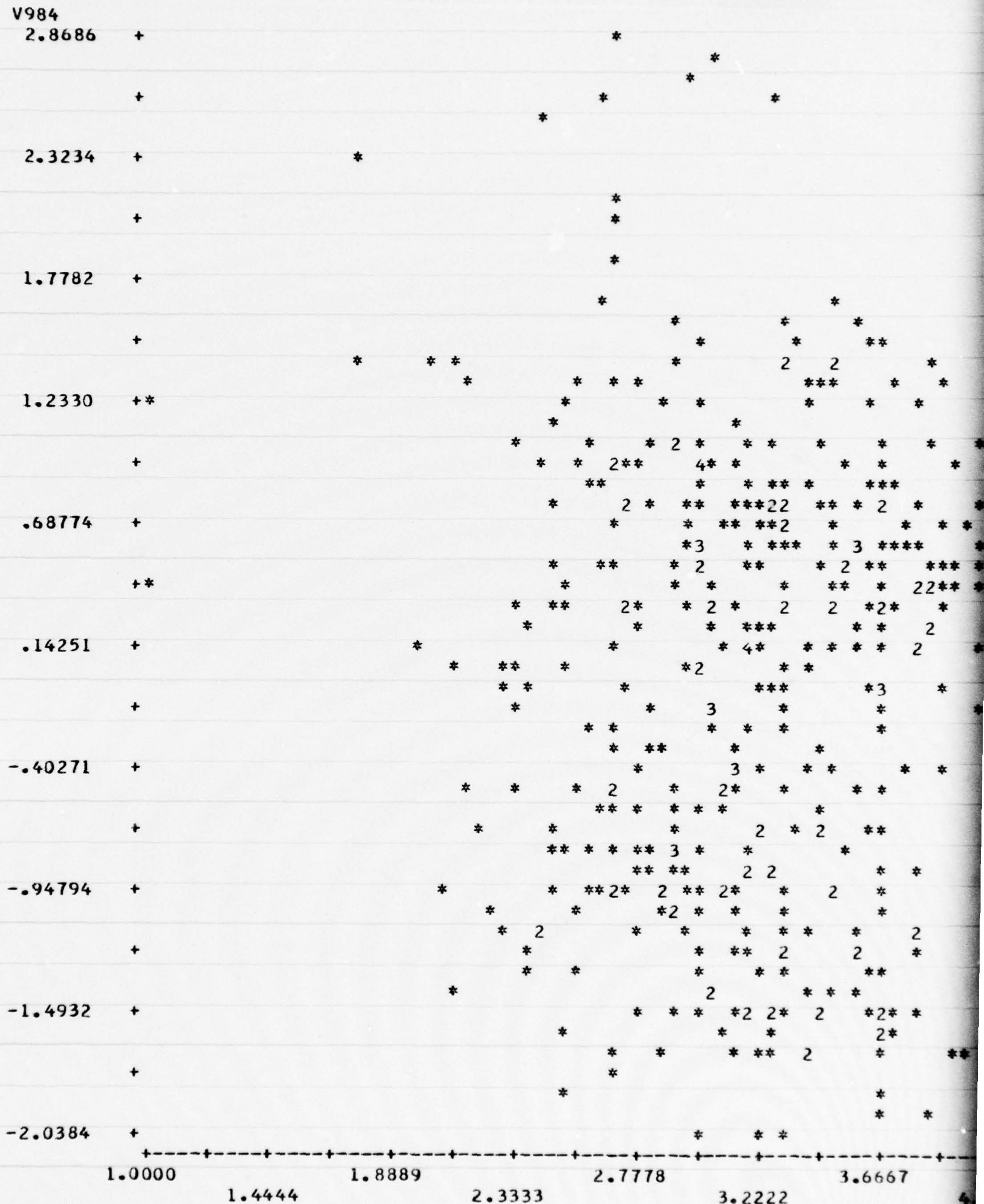

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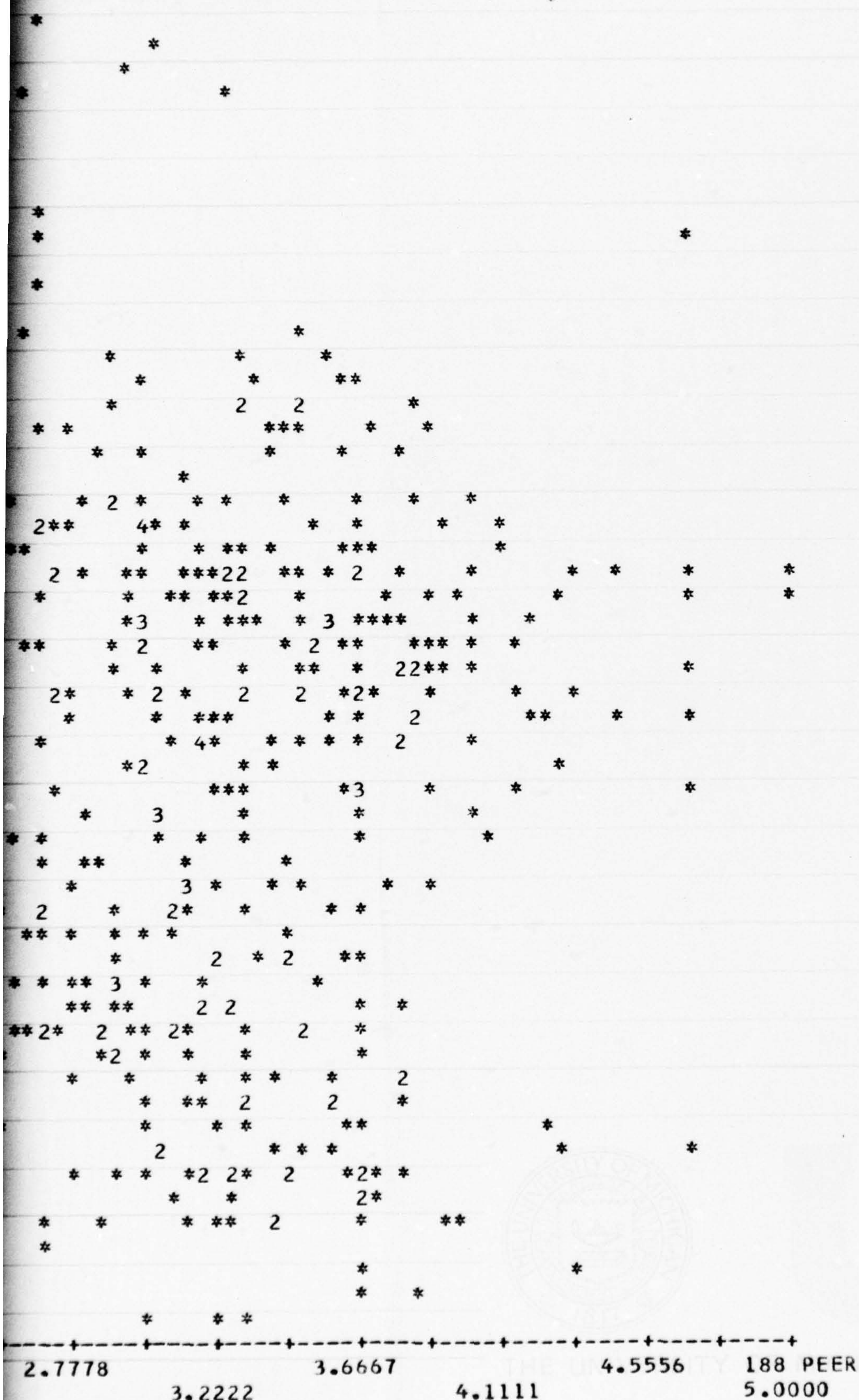

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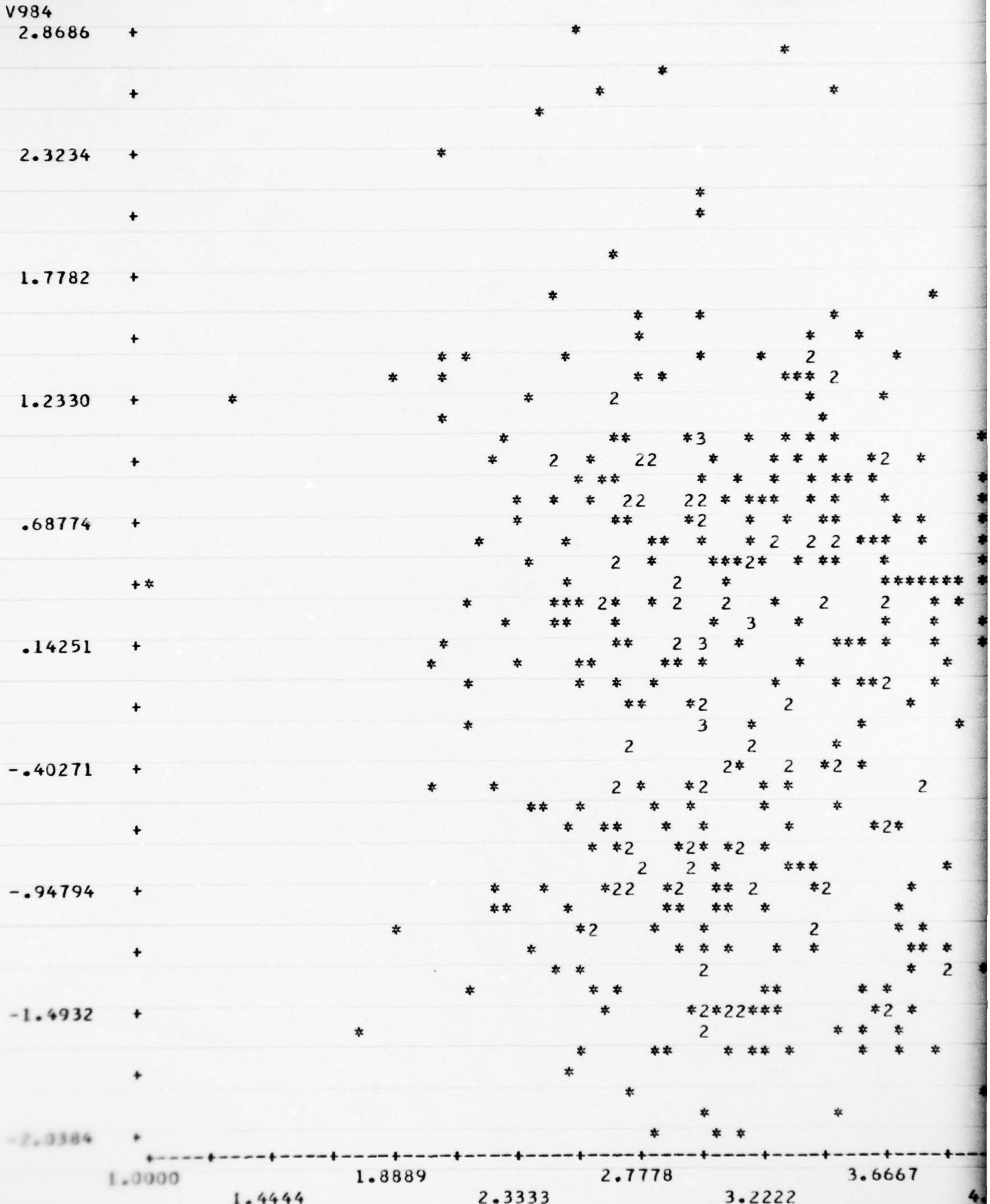

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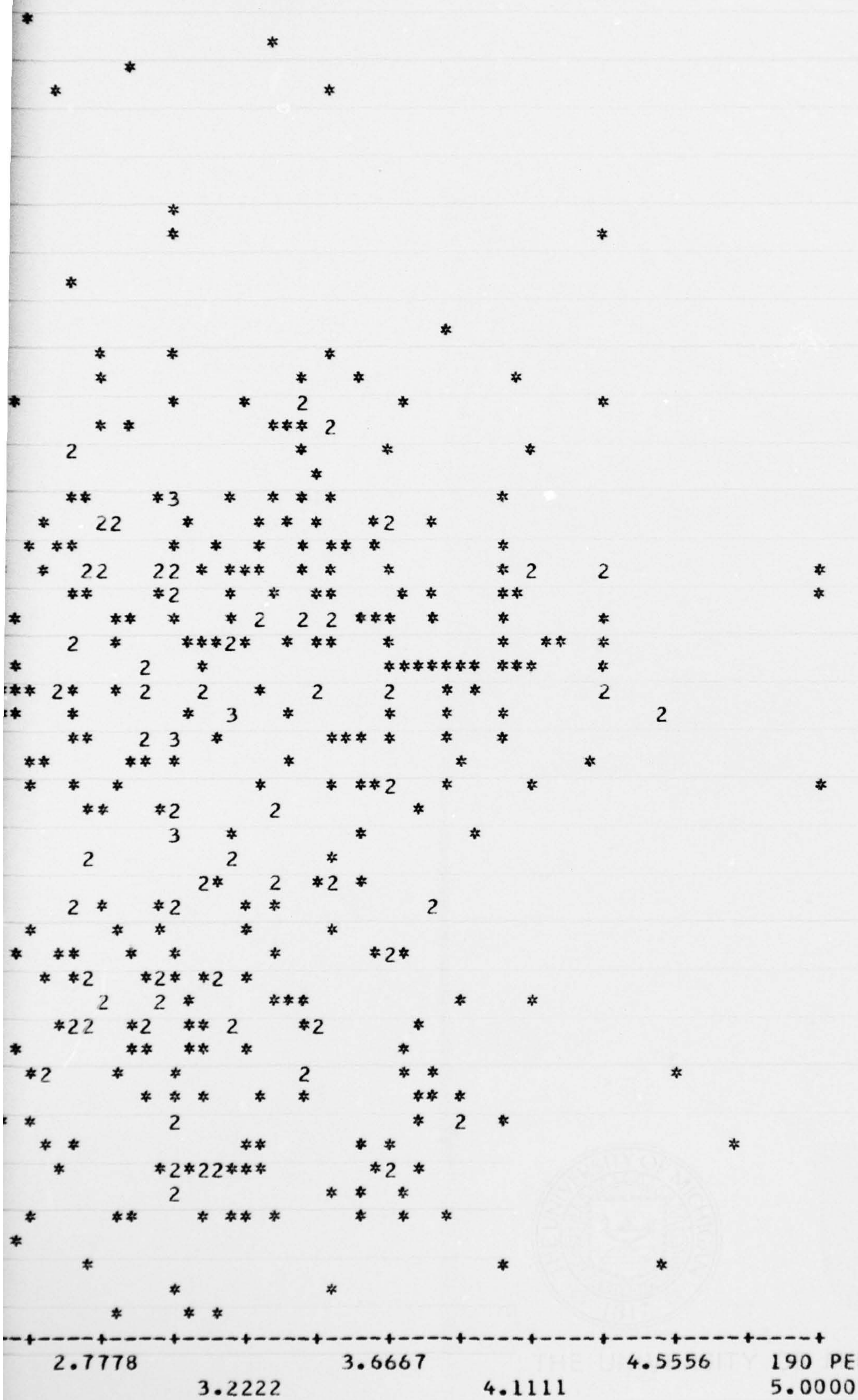

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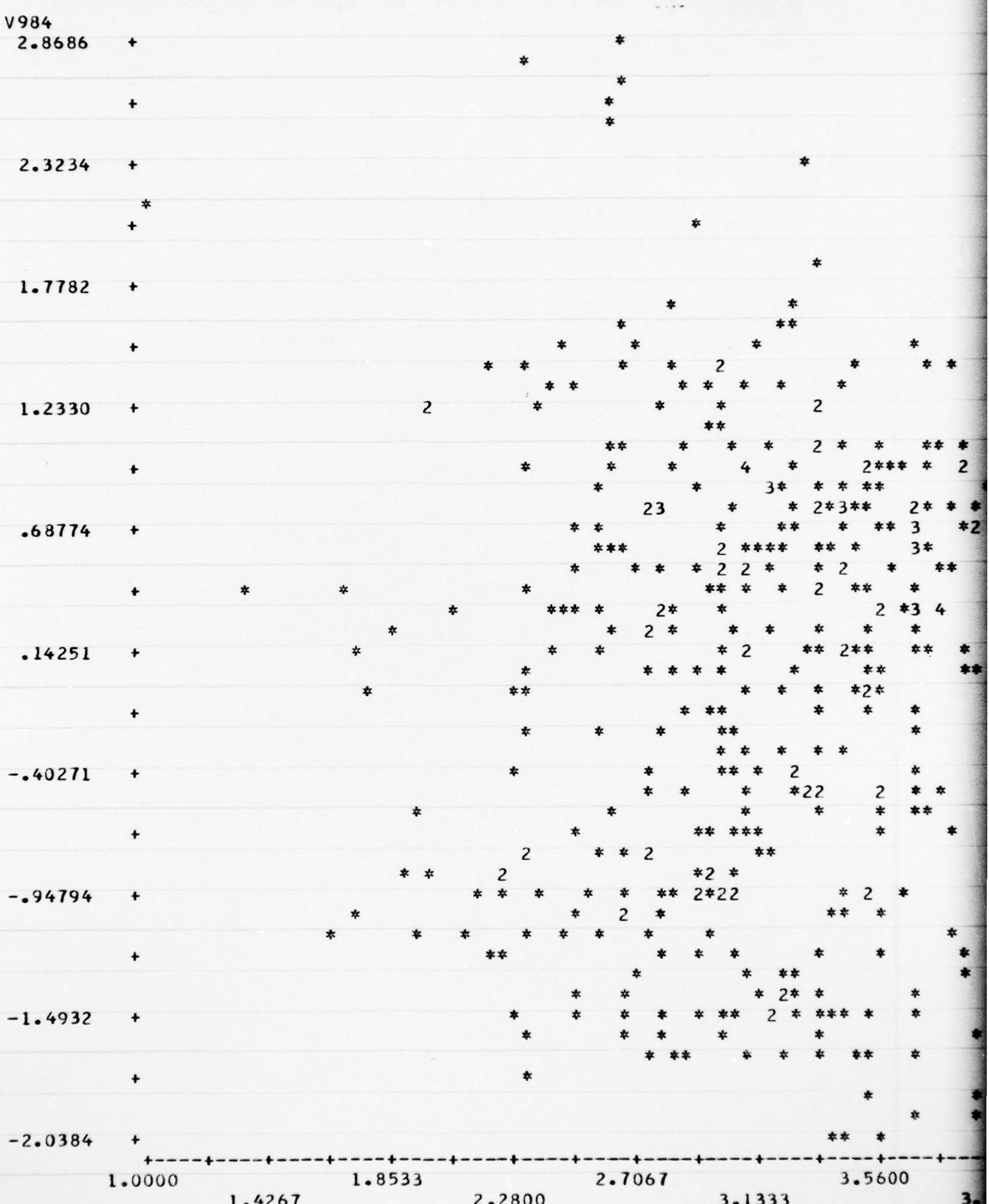

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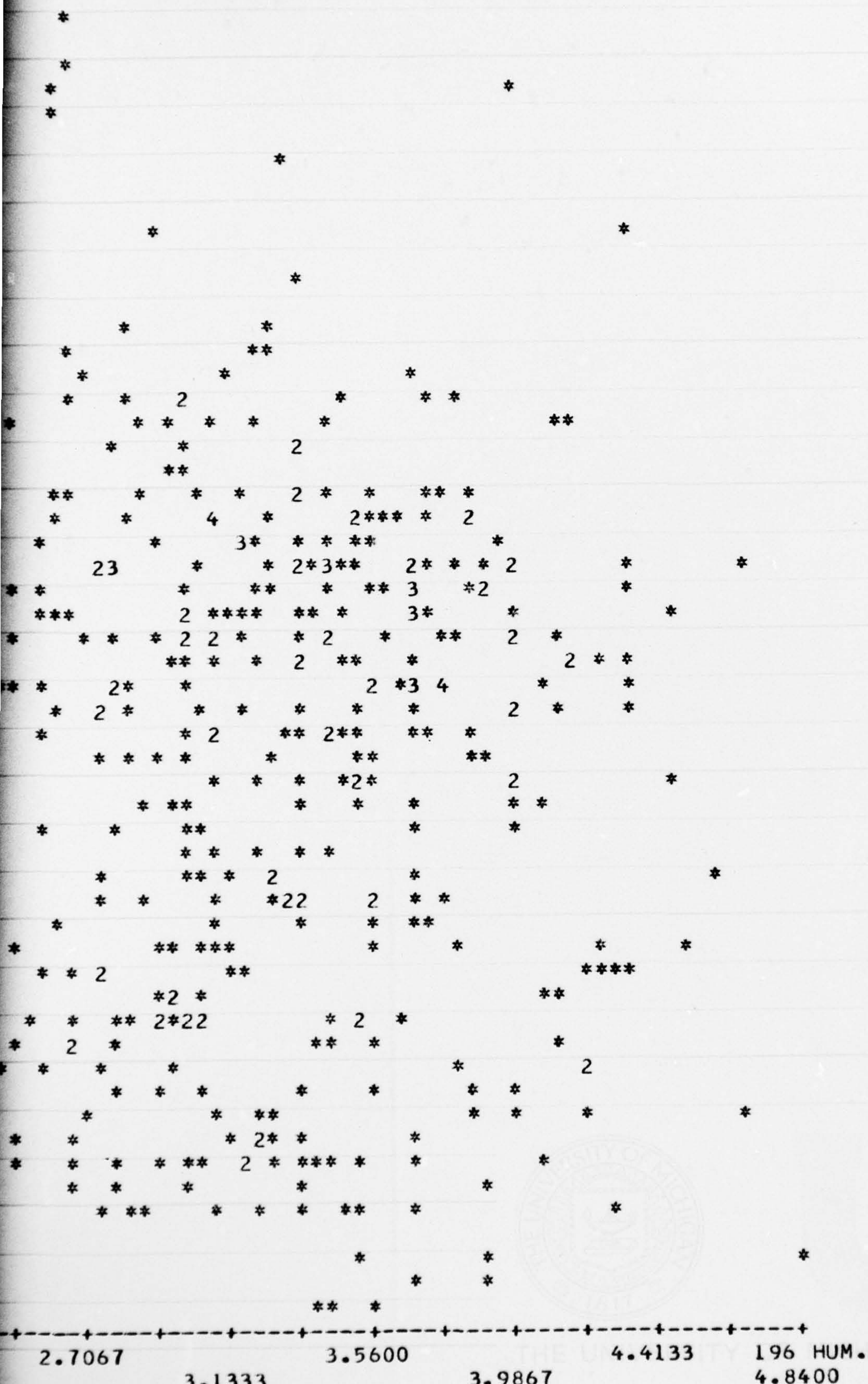

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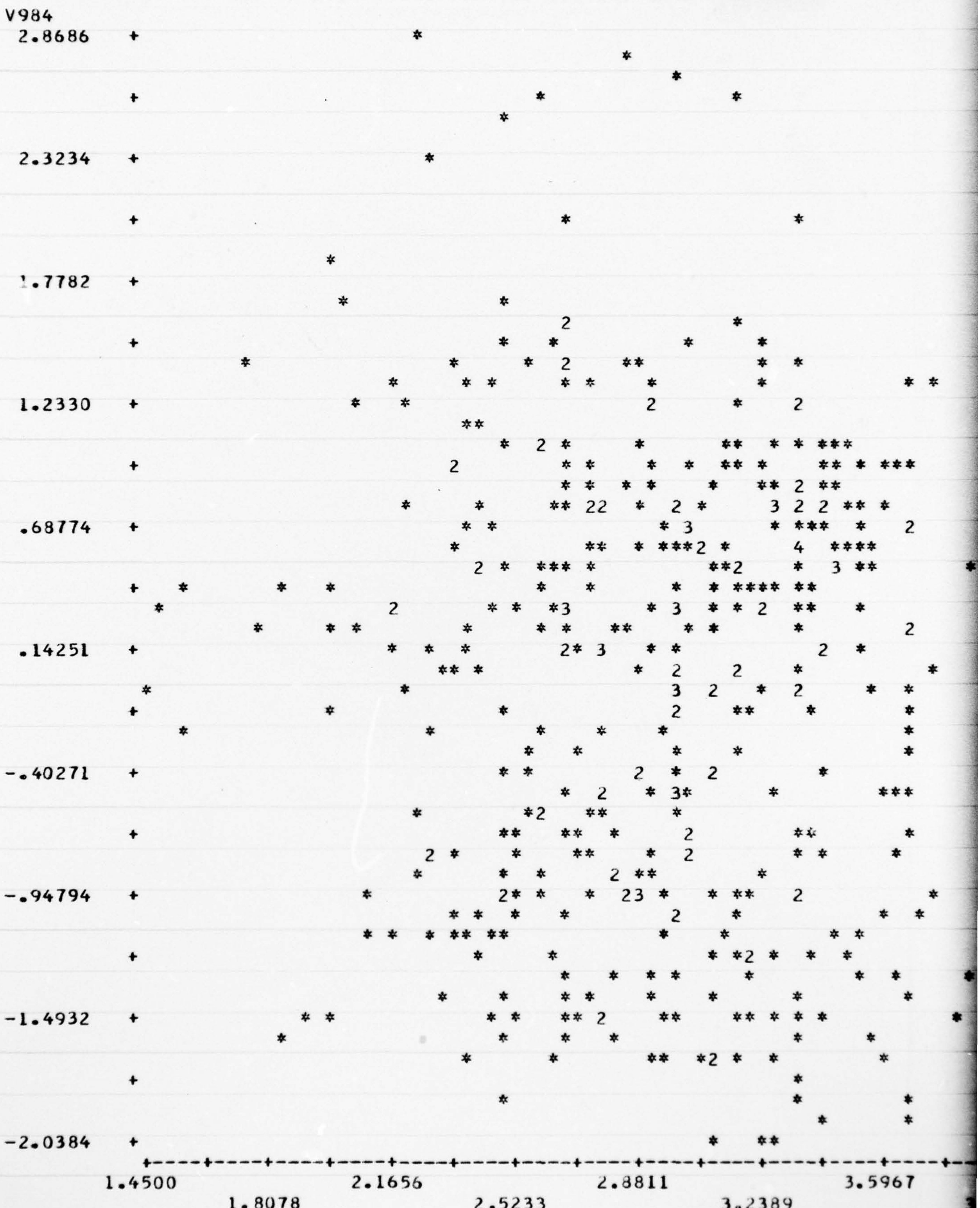

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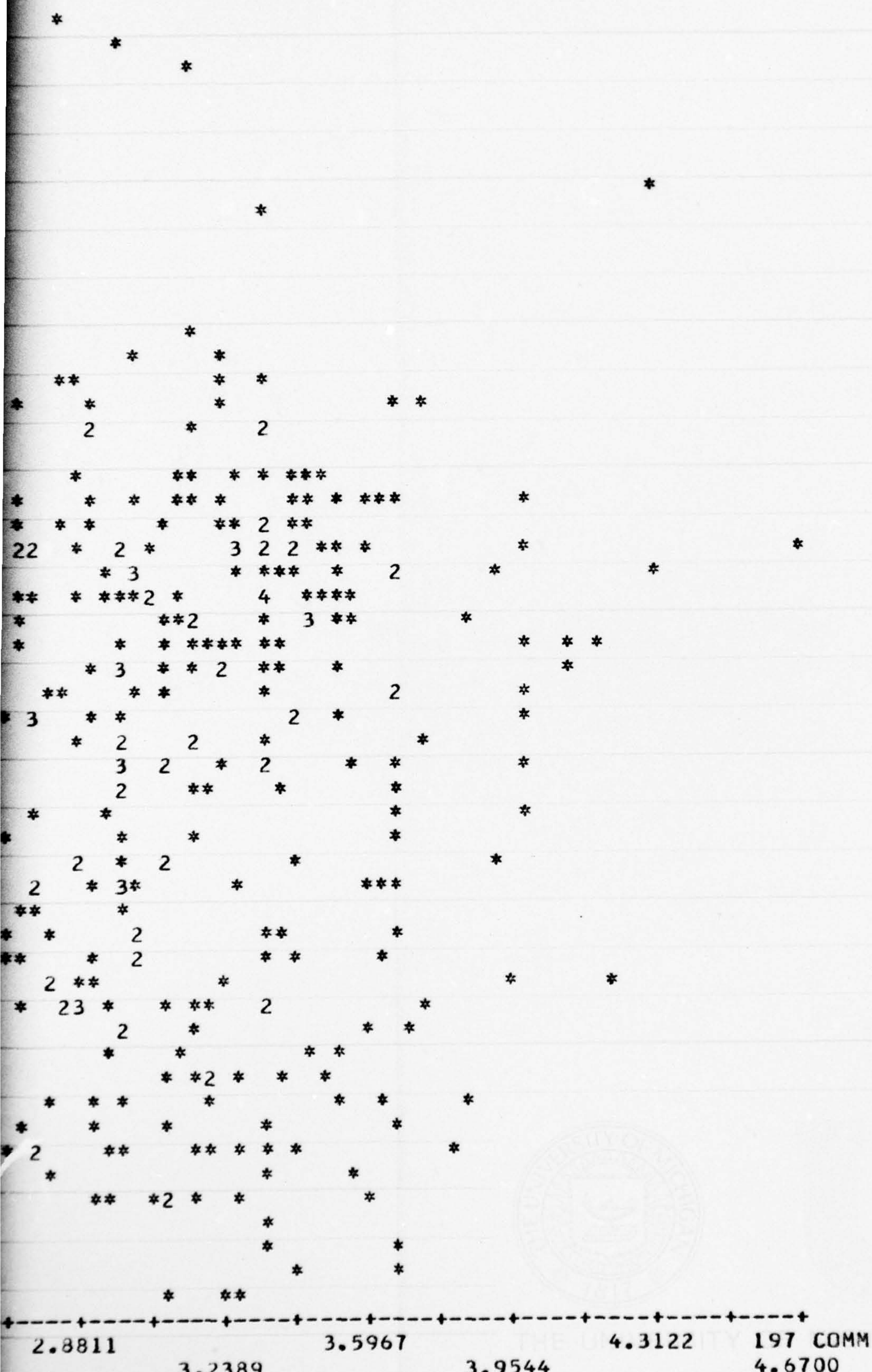

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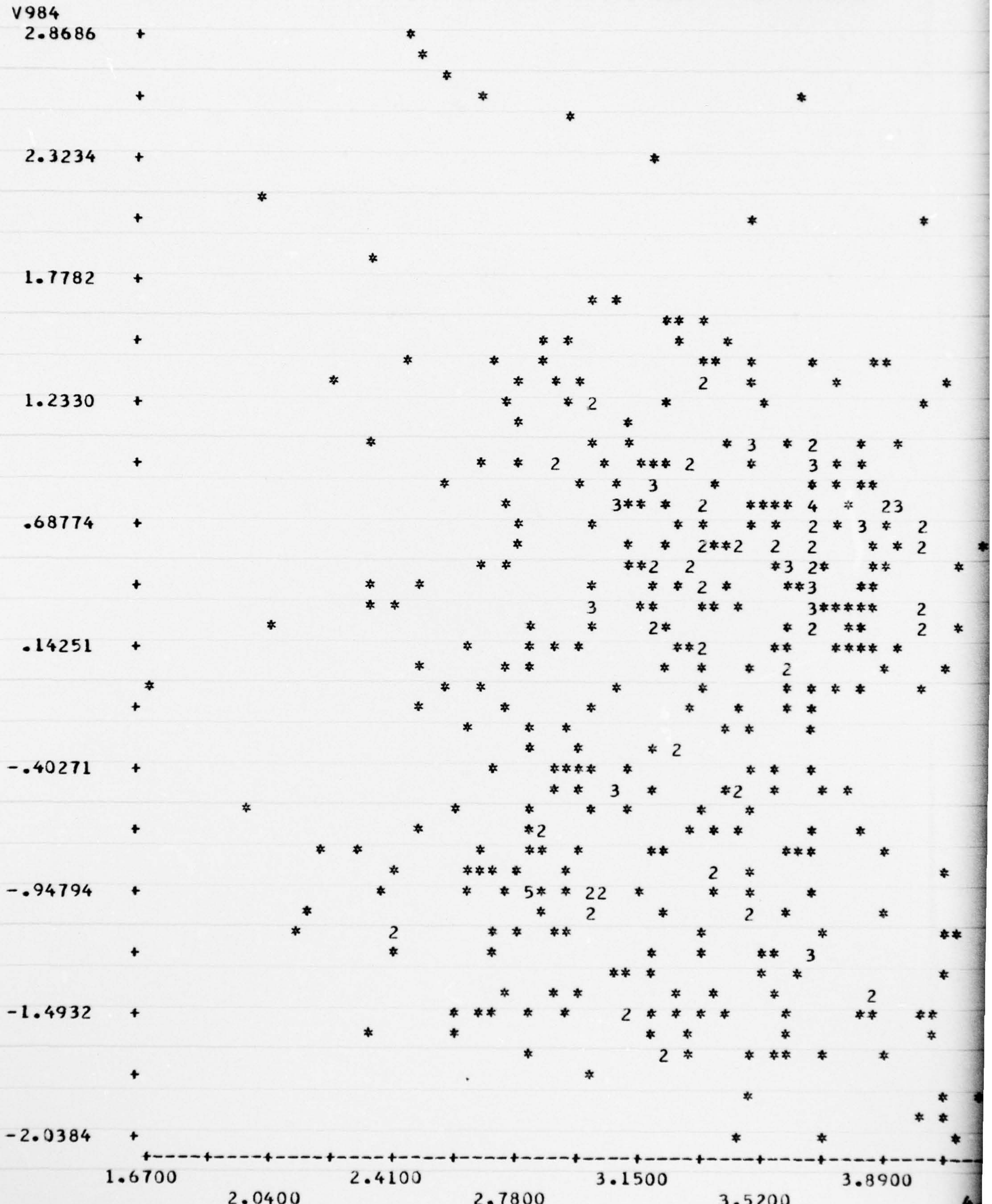

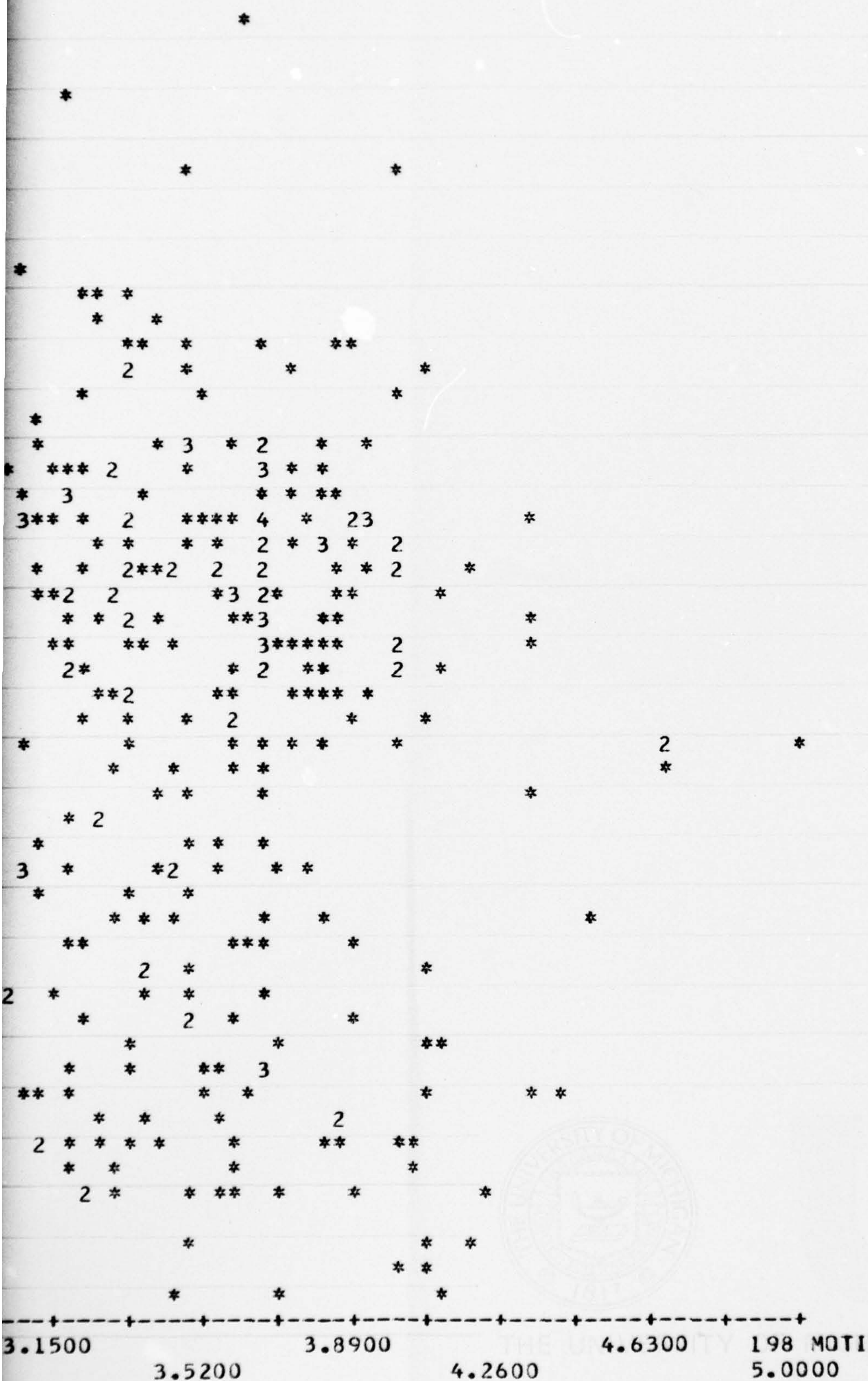
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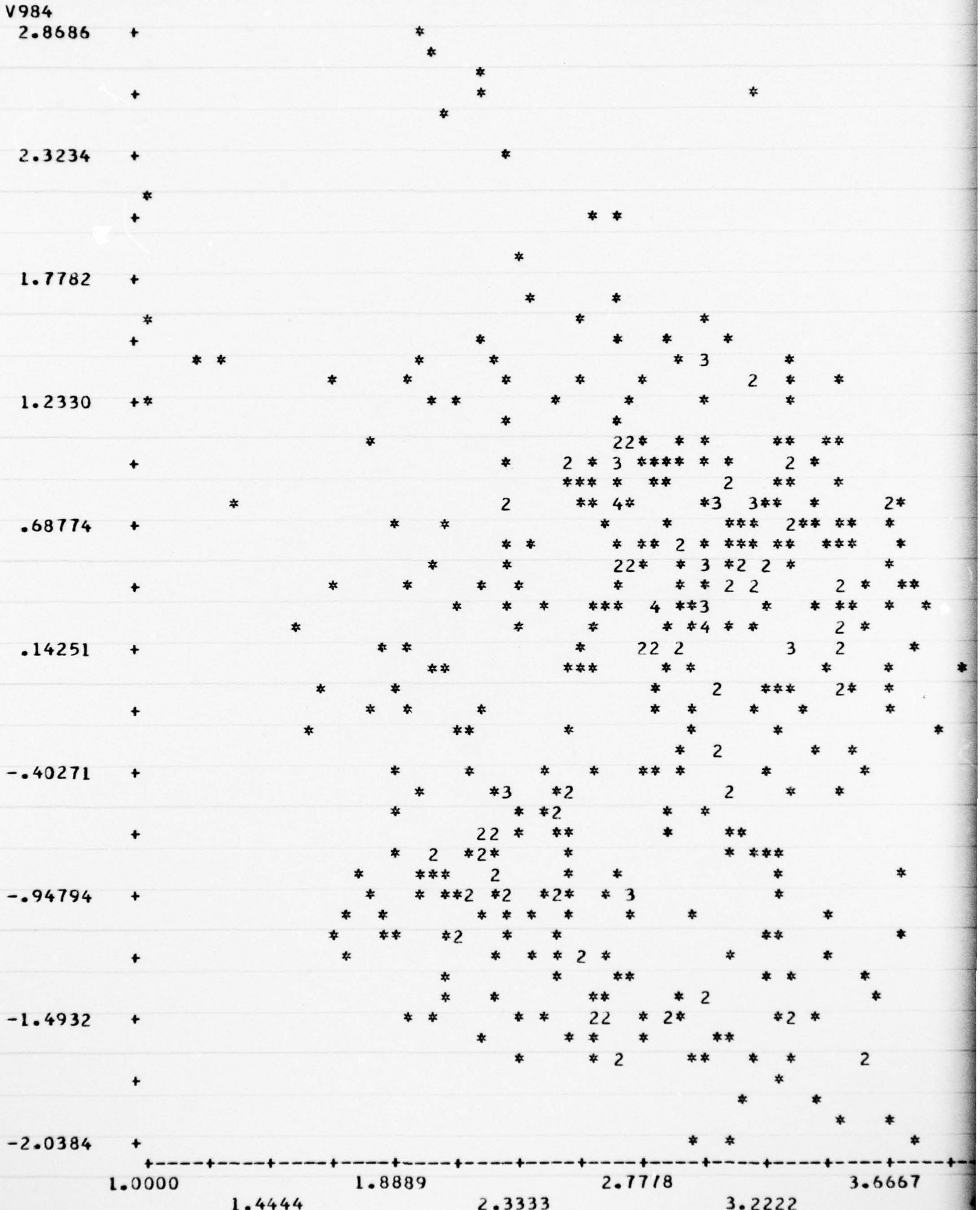

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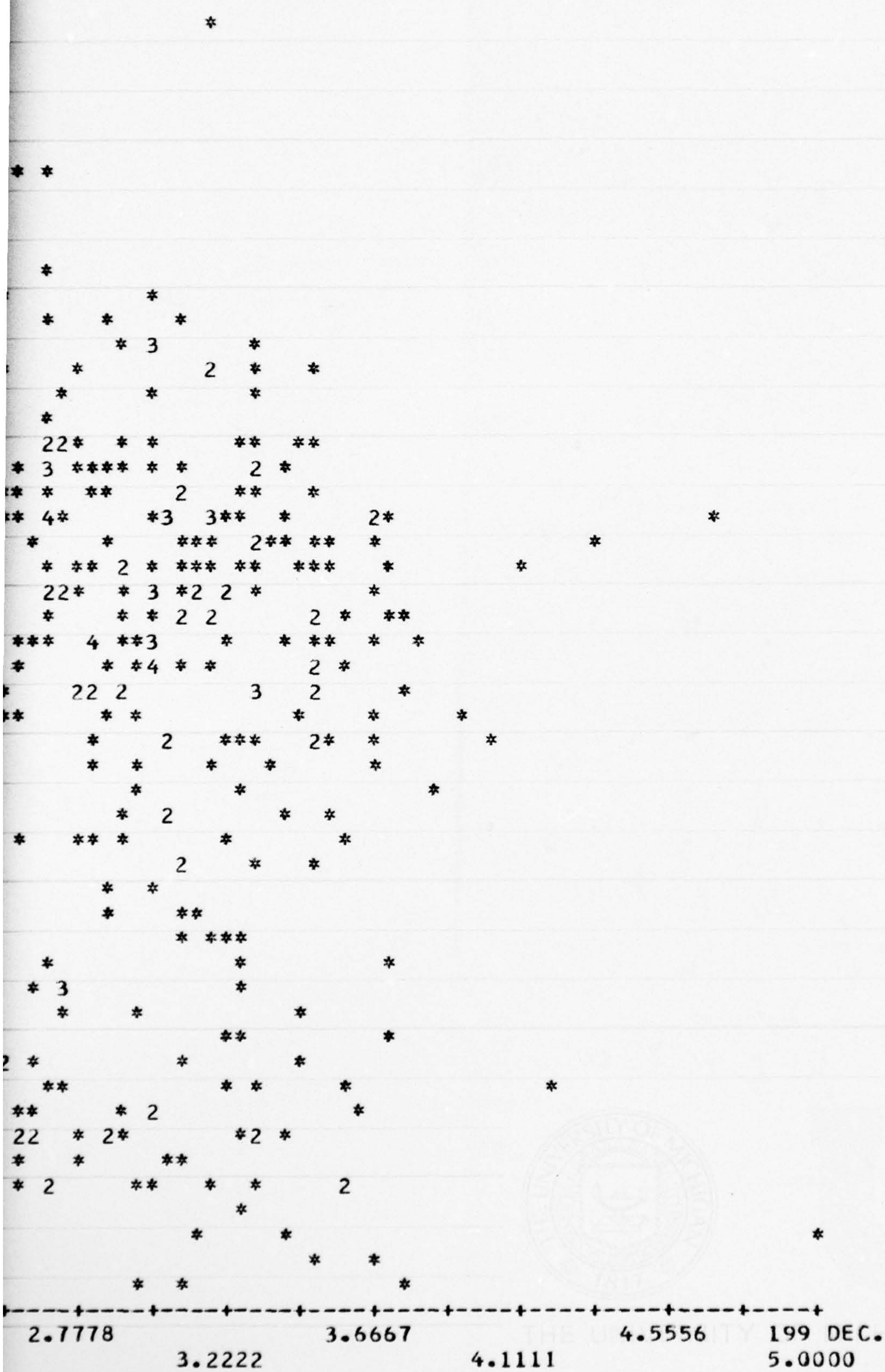

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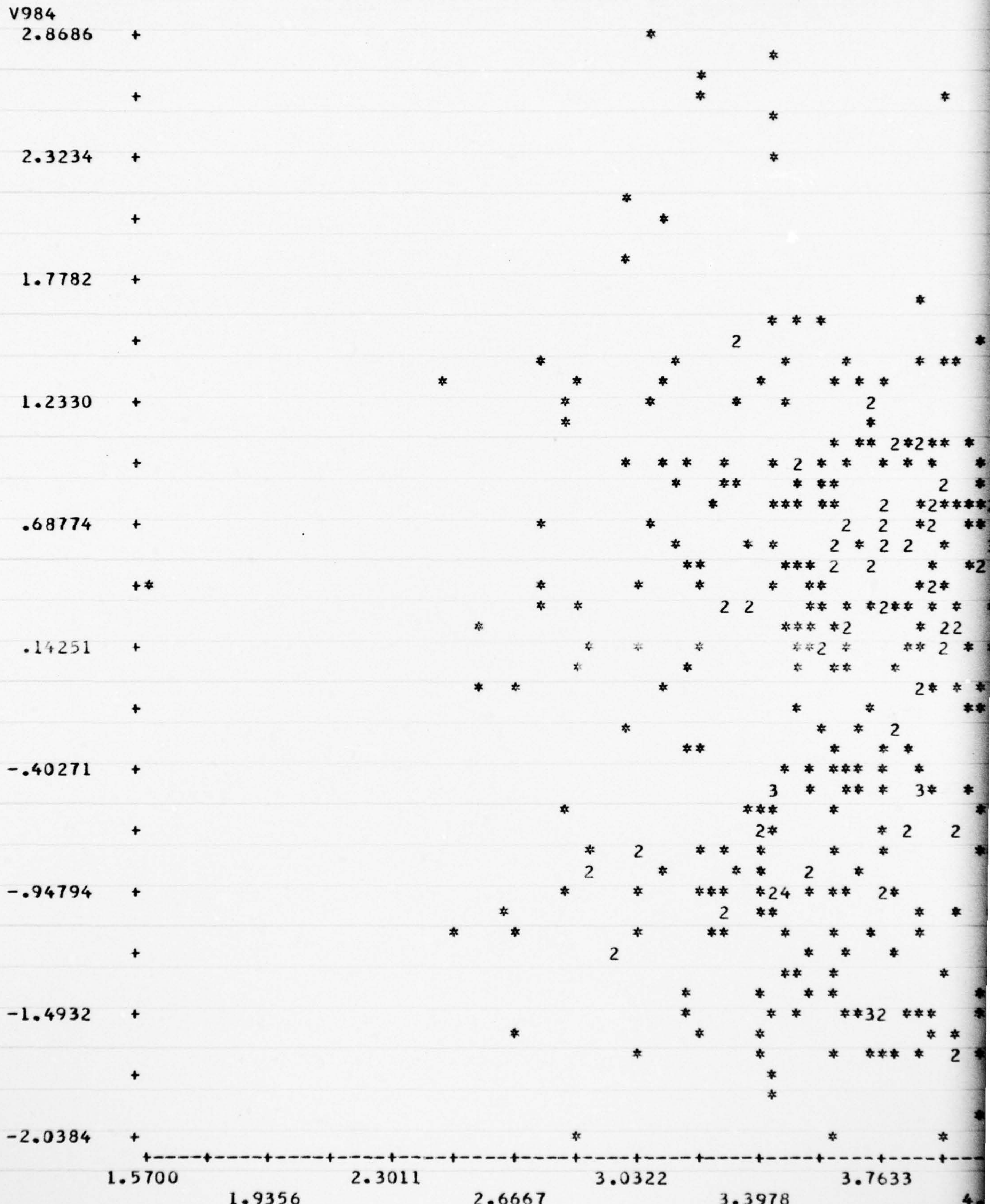

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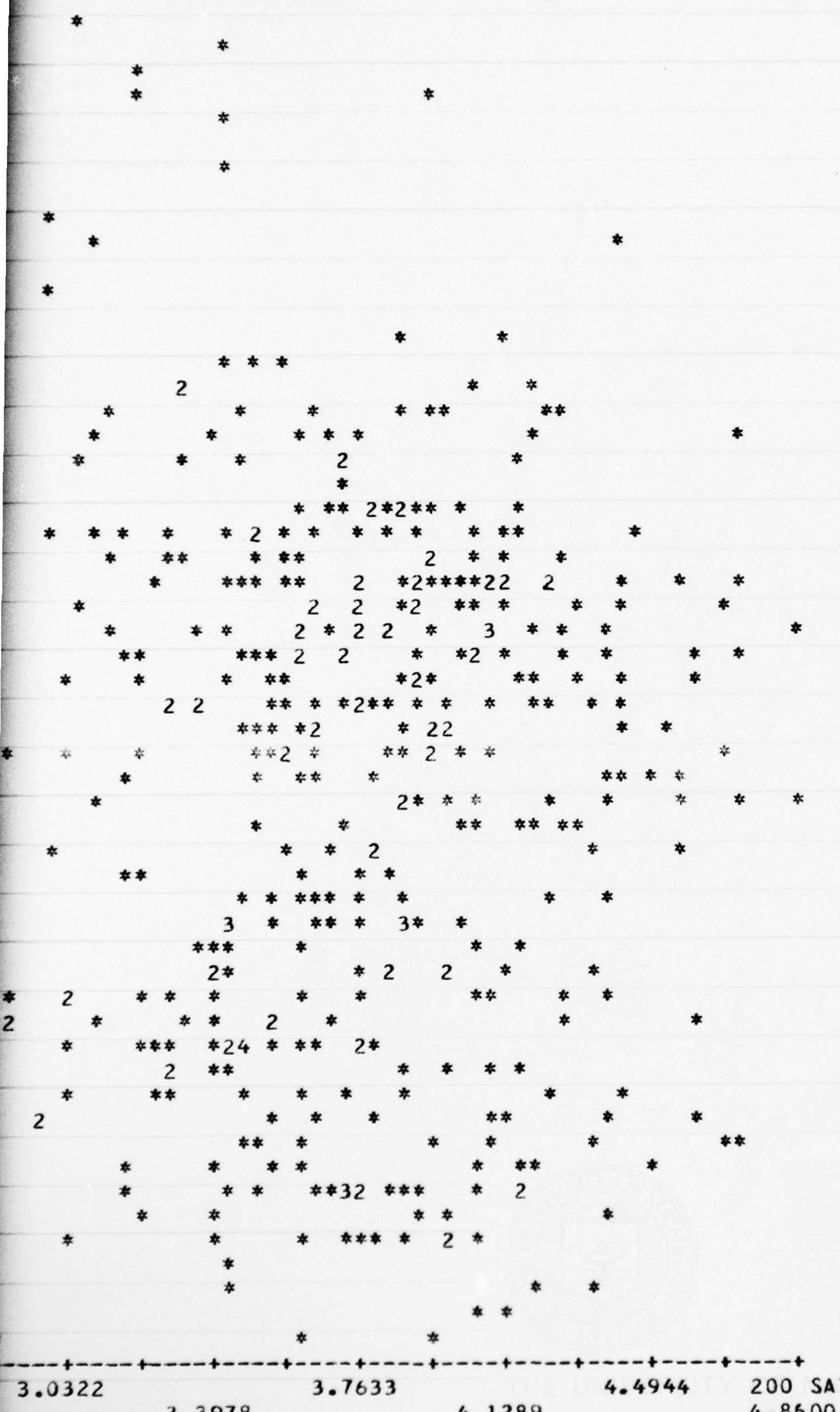

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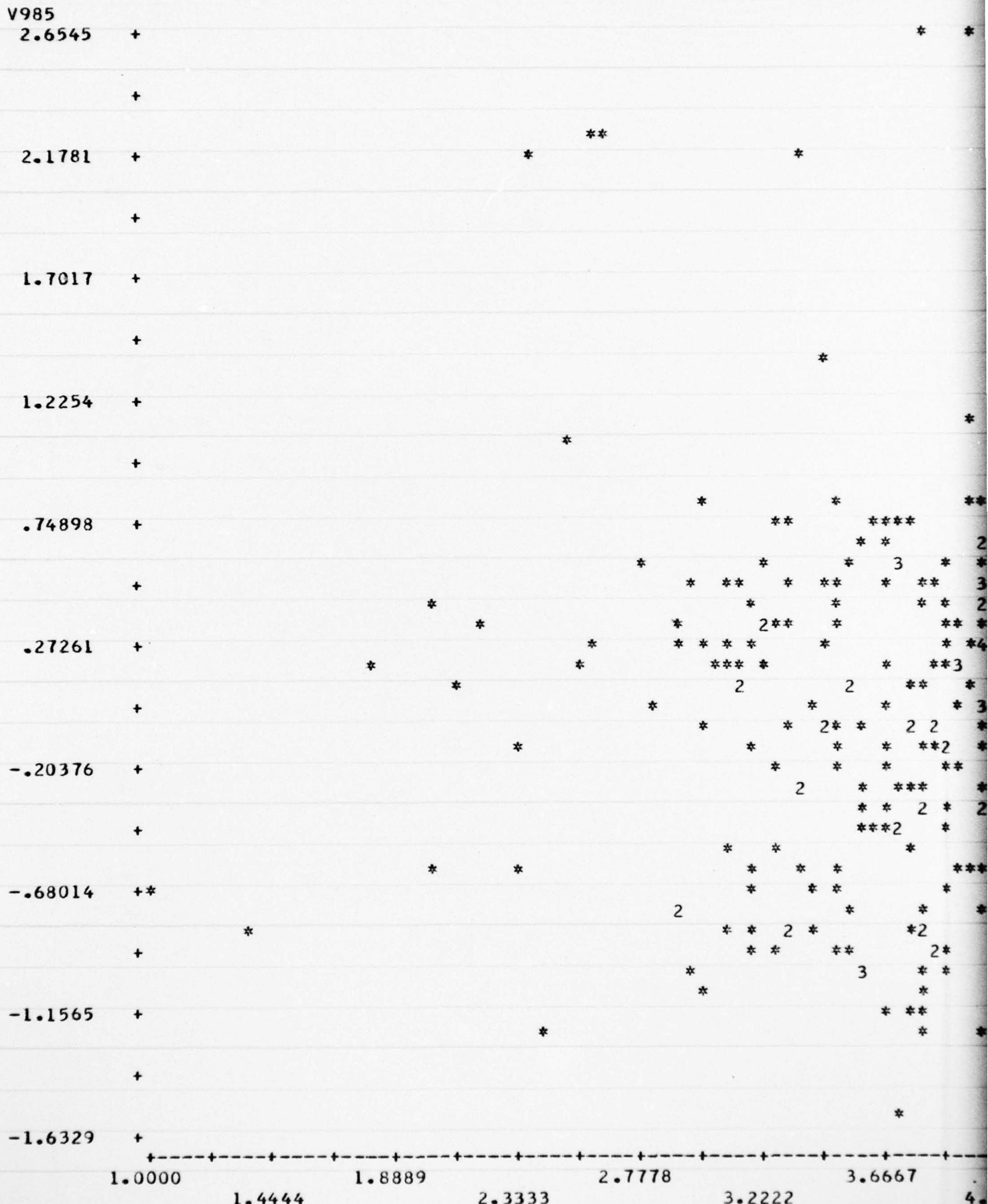

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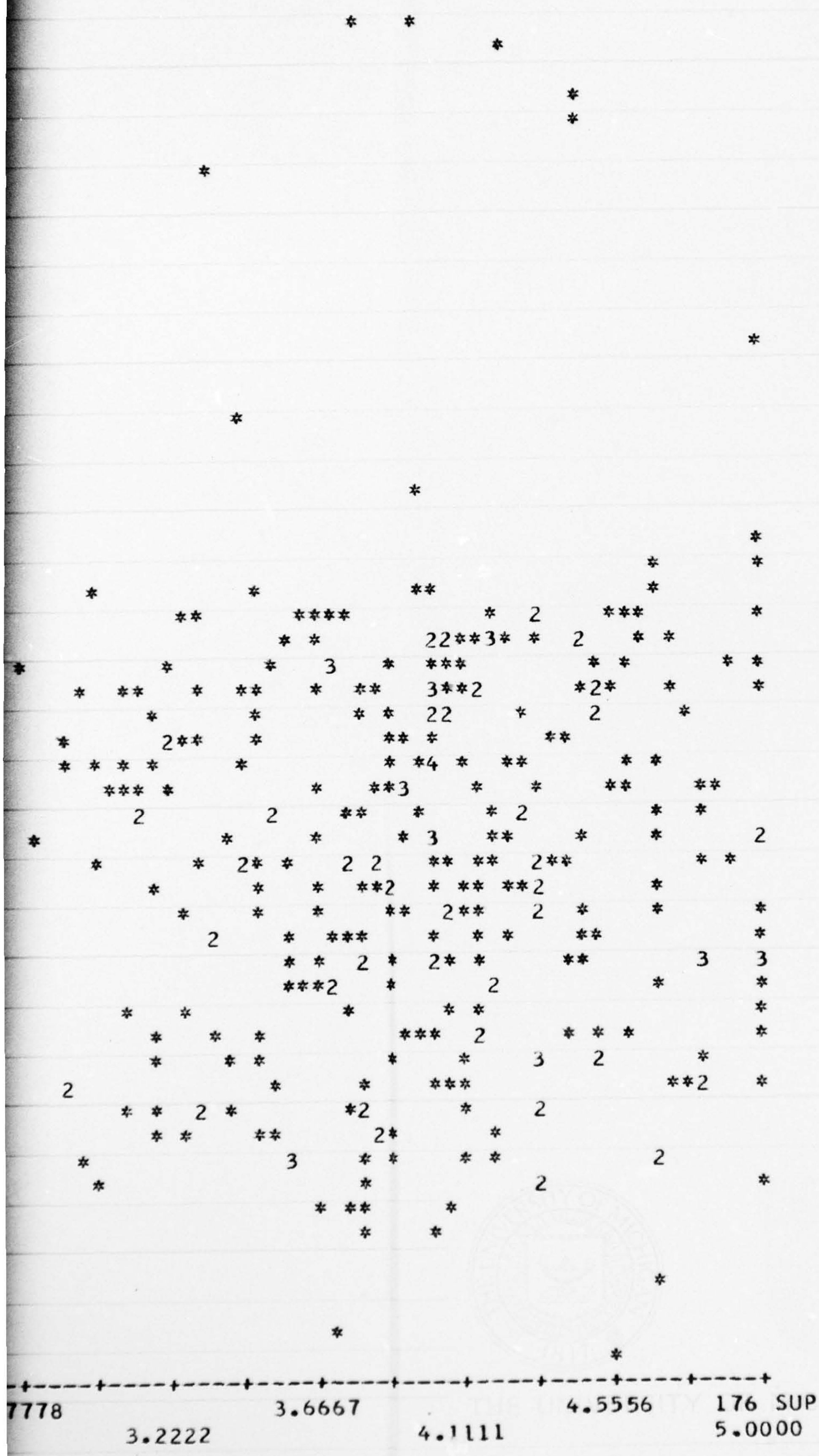

THE UNIVERSITY OF MICHIGAN COMPUTING CENTER

AD-A045 068 MICHIGAN UNIV ANN ARBOR INST FOR SOCIAL RESEARCH F/G 5/9
FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH T--ETC(U)
JUN 77 A S DAVENPORT, J B LAPOINTE N00014-76-C-0362

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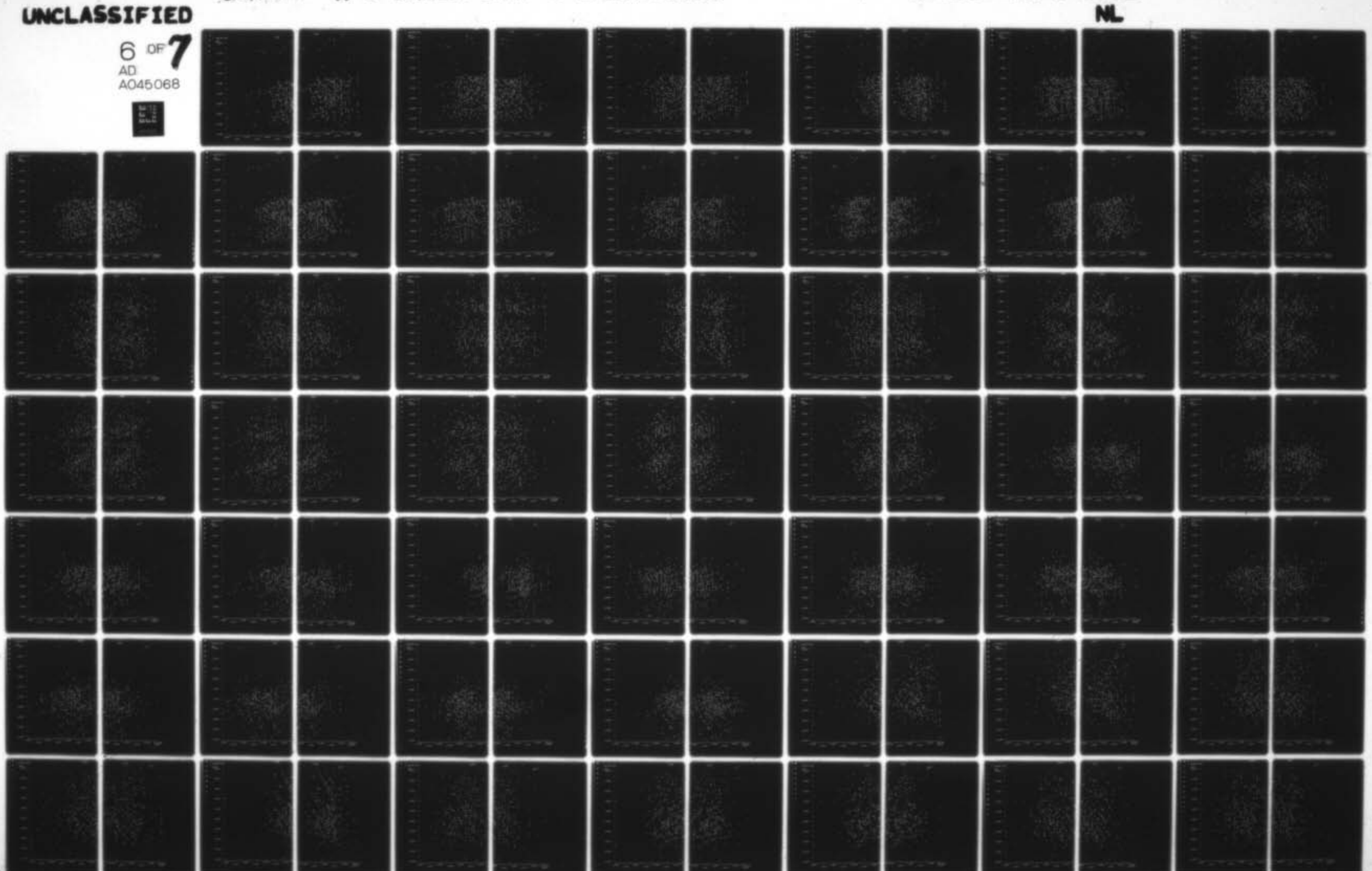

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MICROCOPY RESOLUTION TEST CHART
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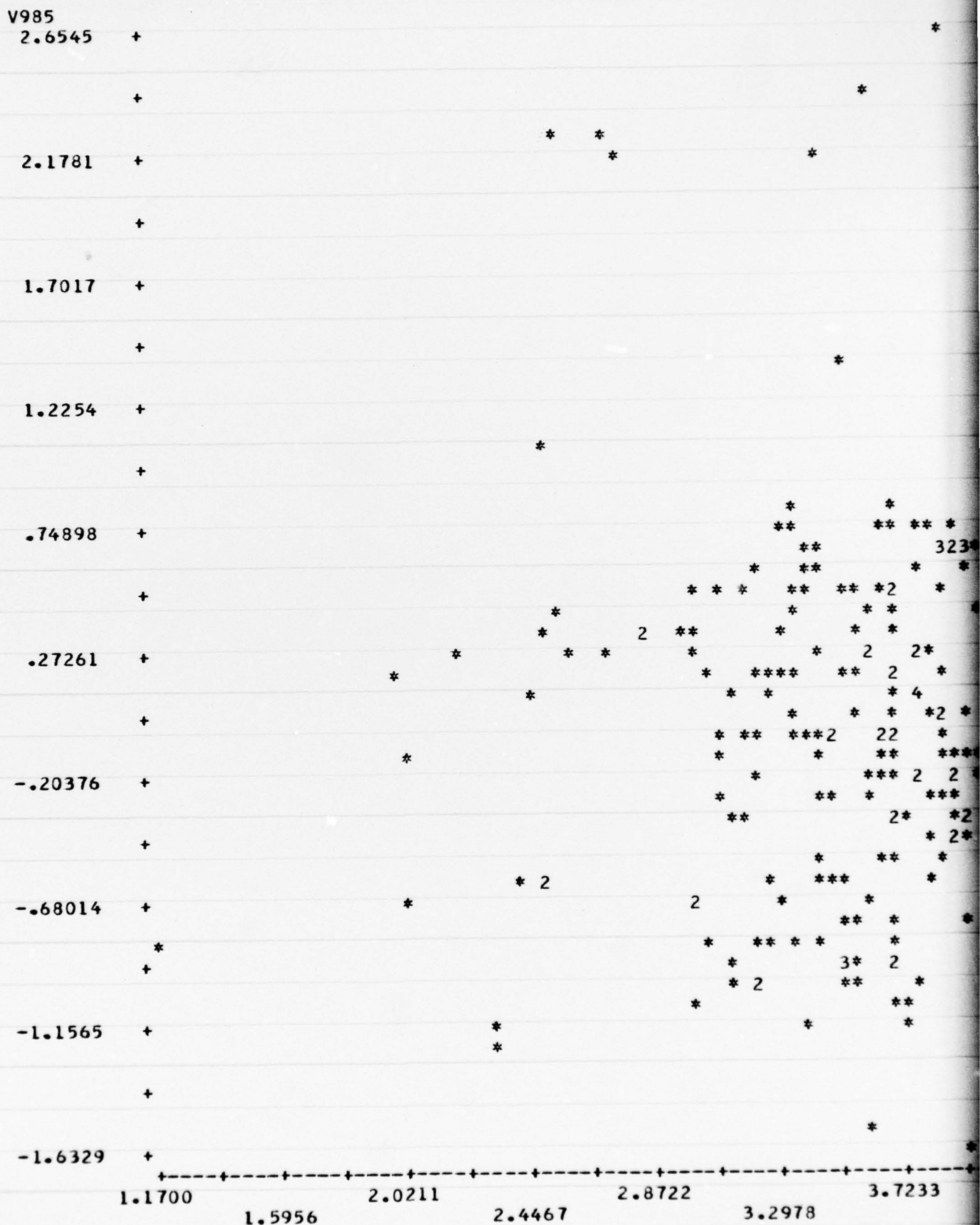

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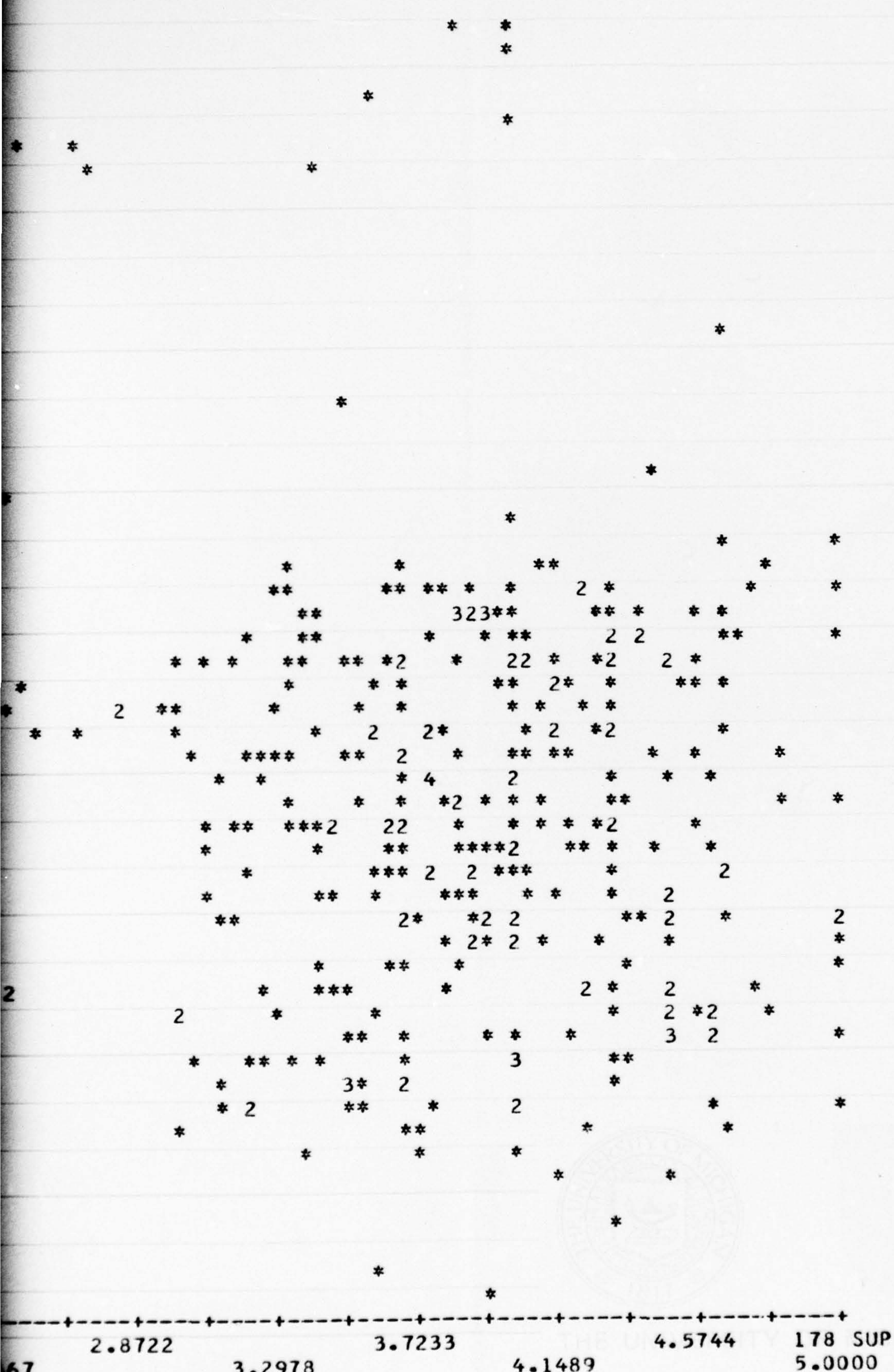

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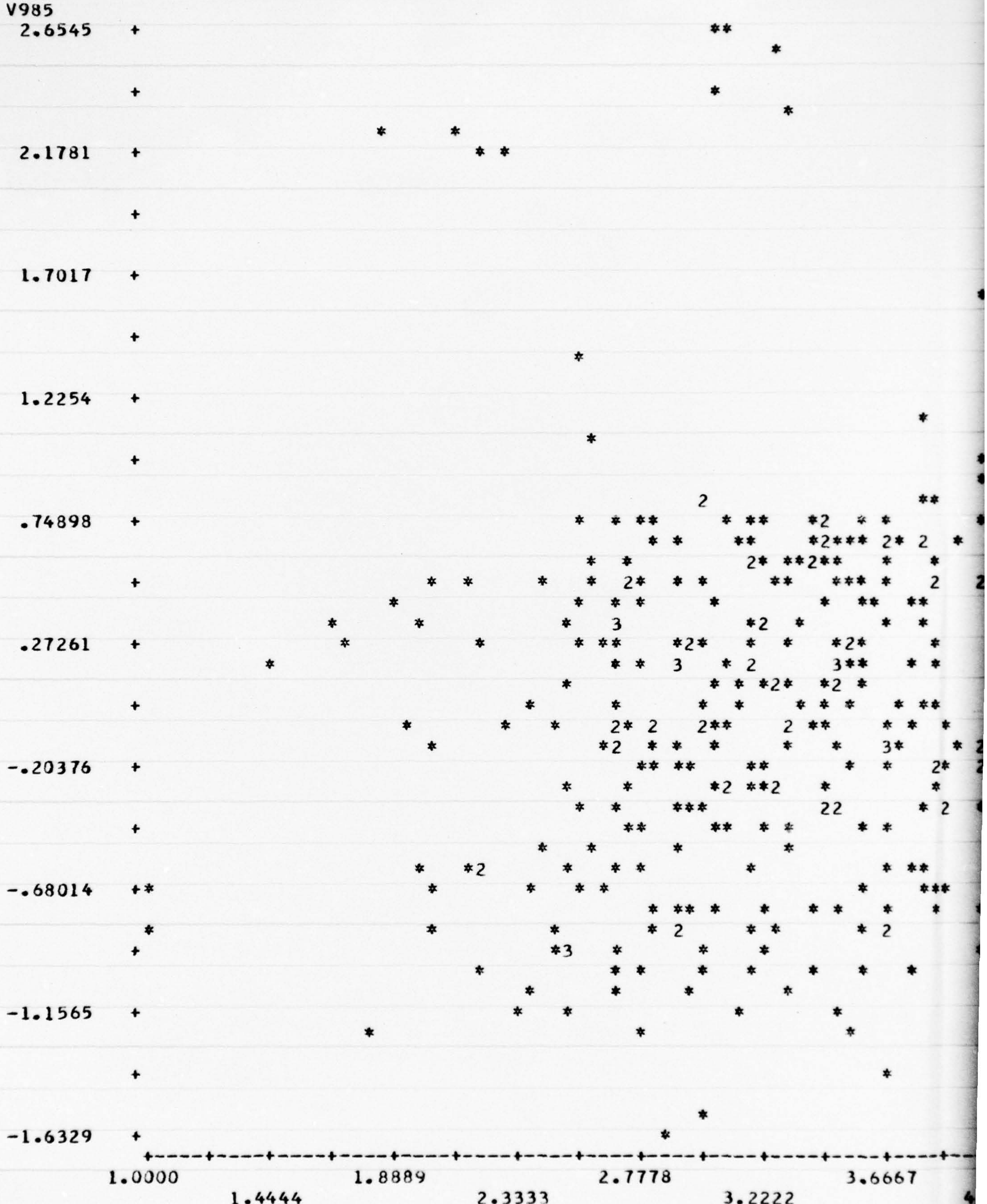

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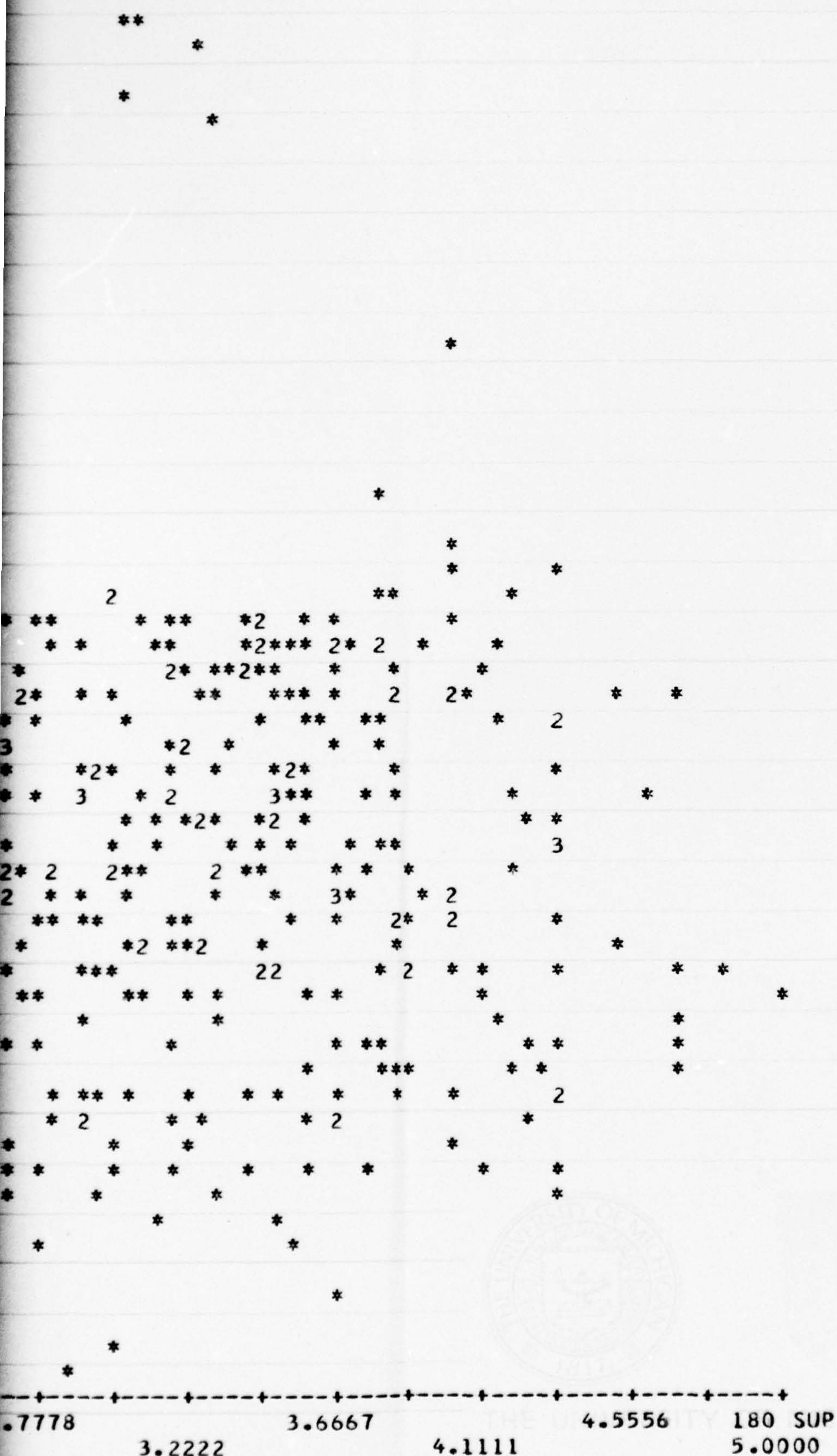

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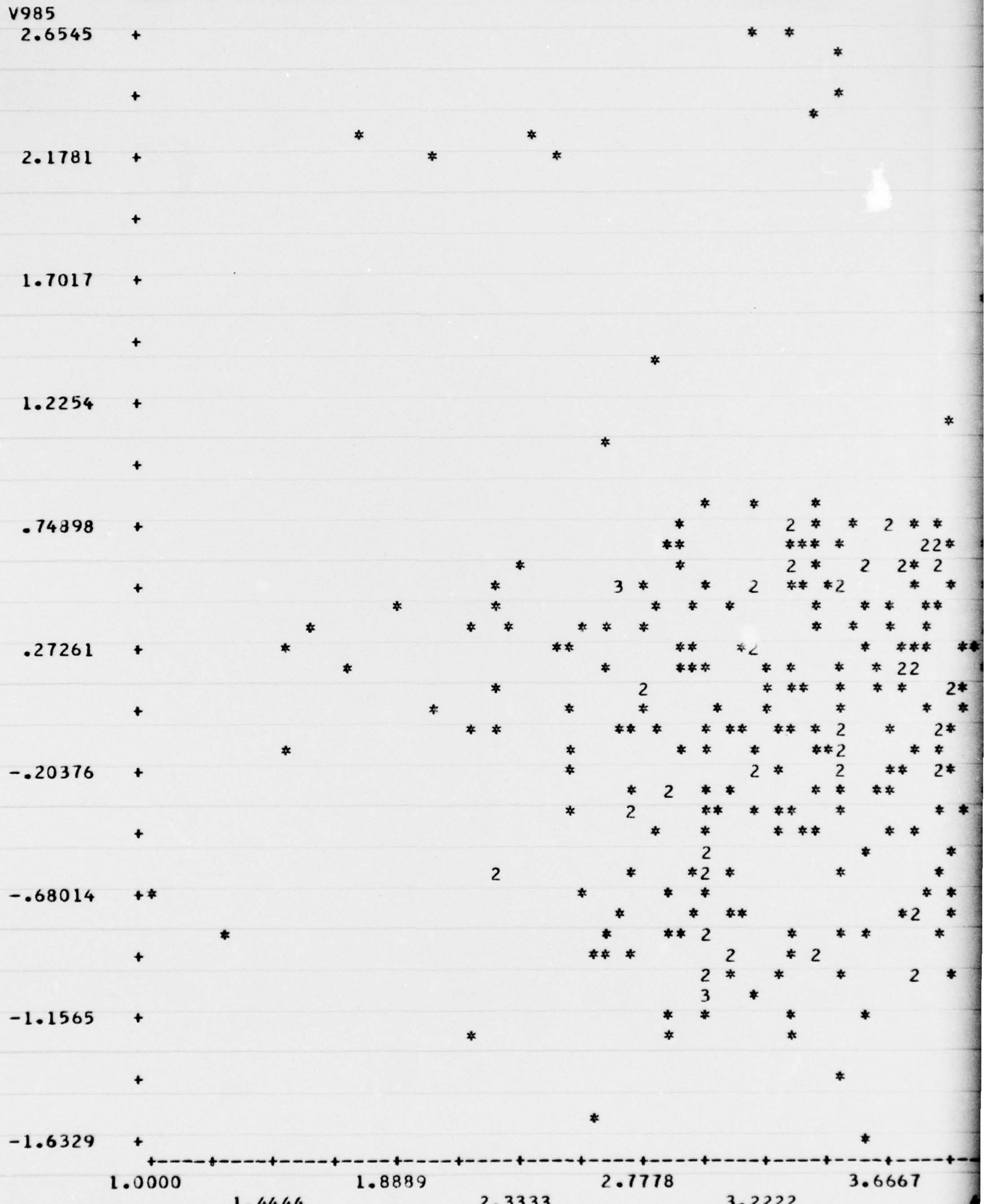

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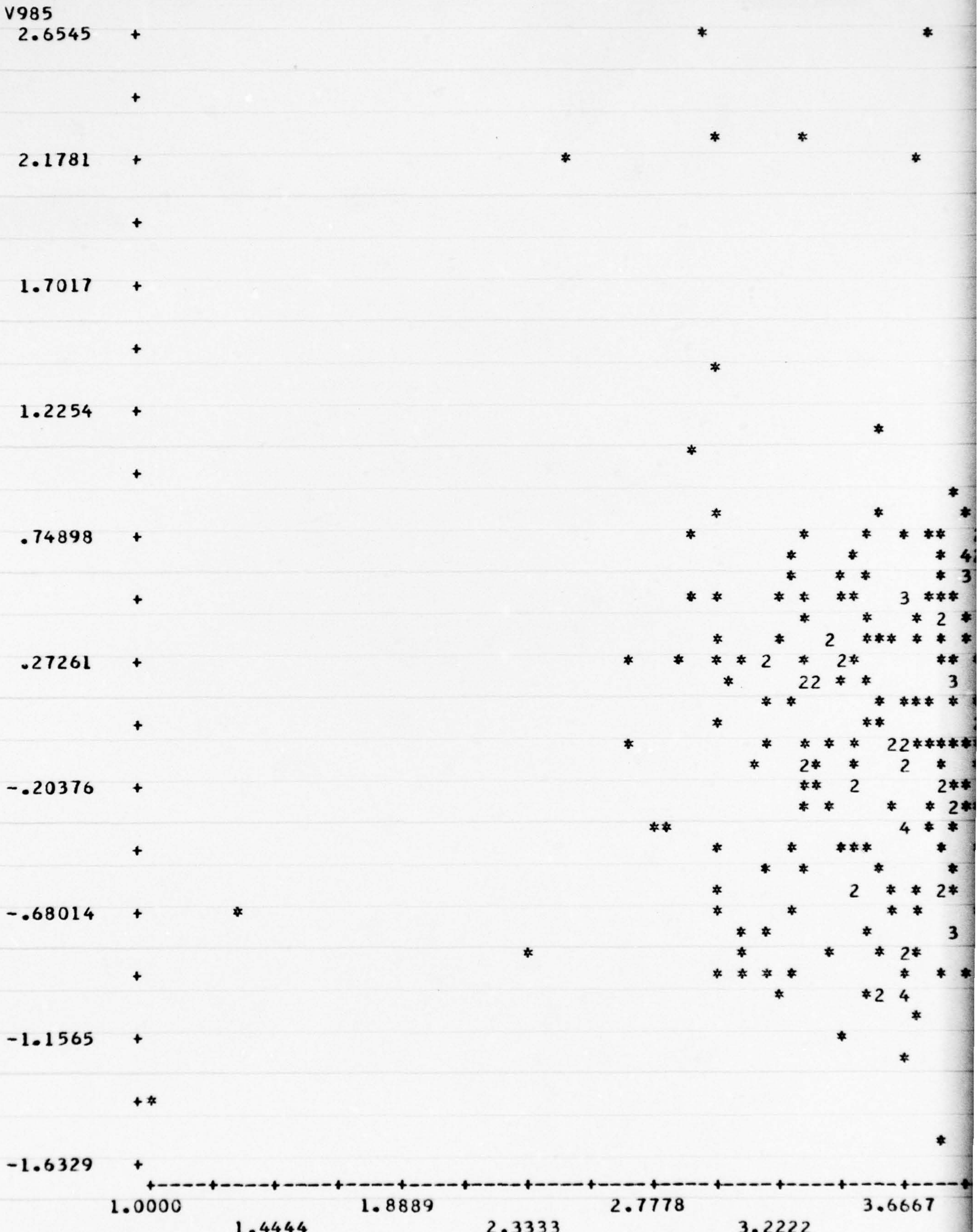

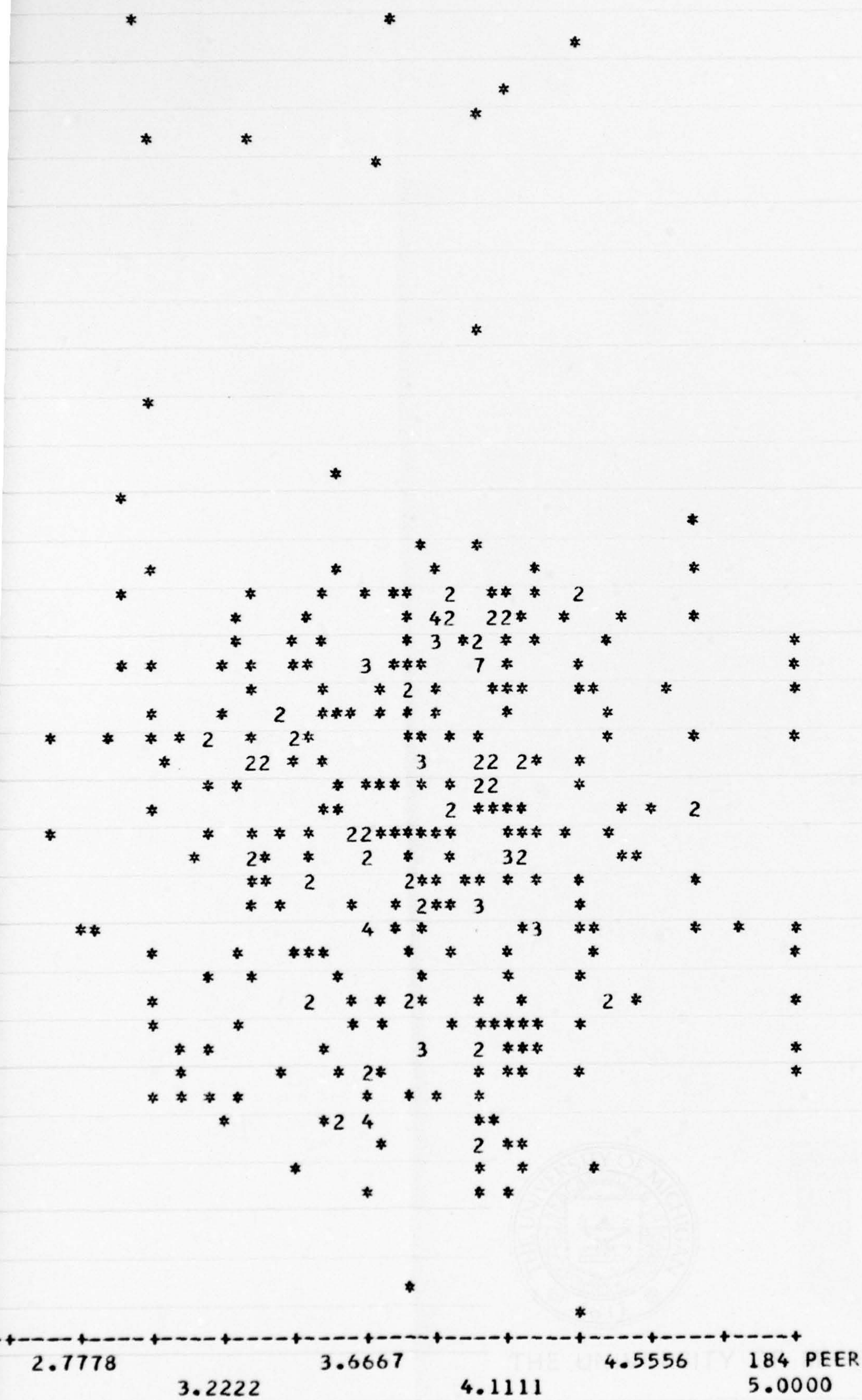
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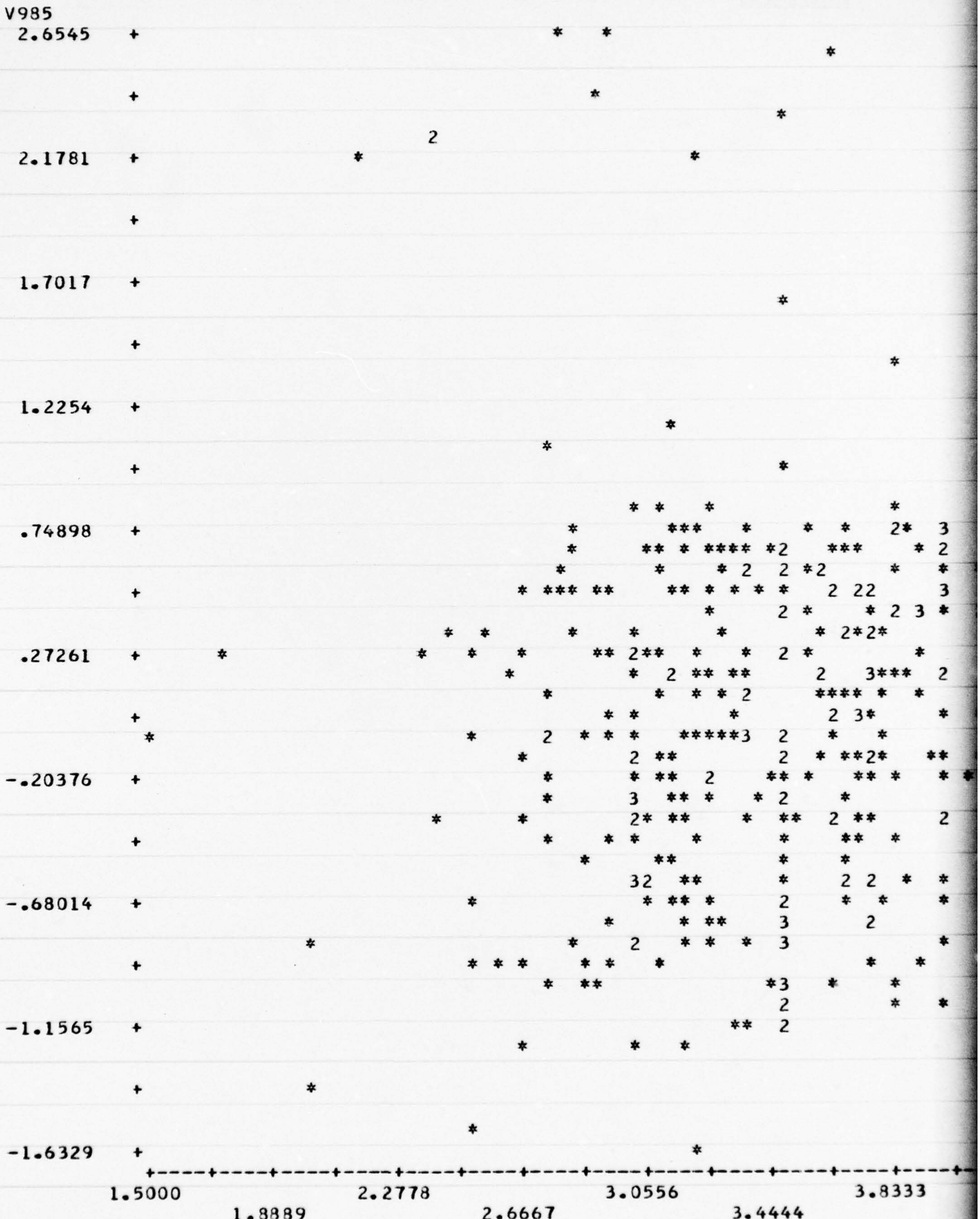

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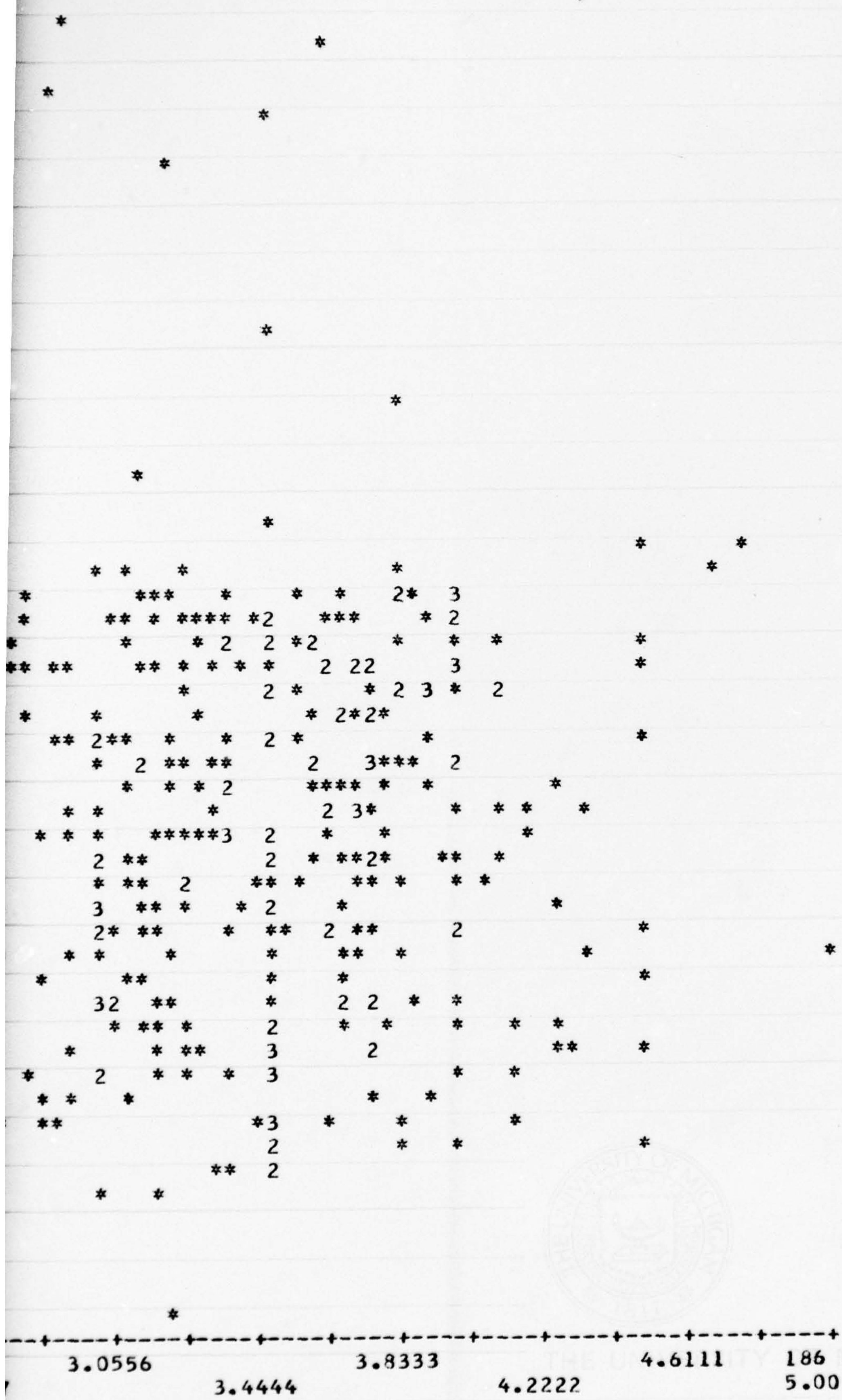

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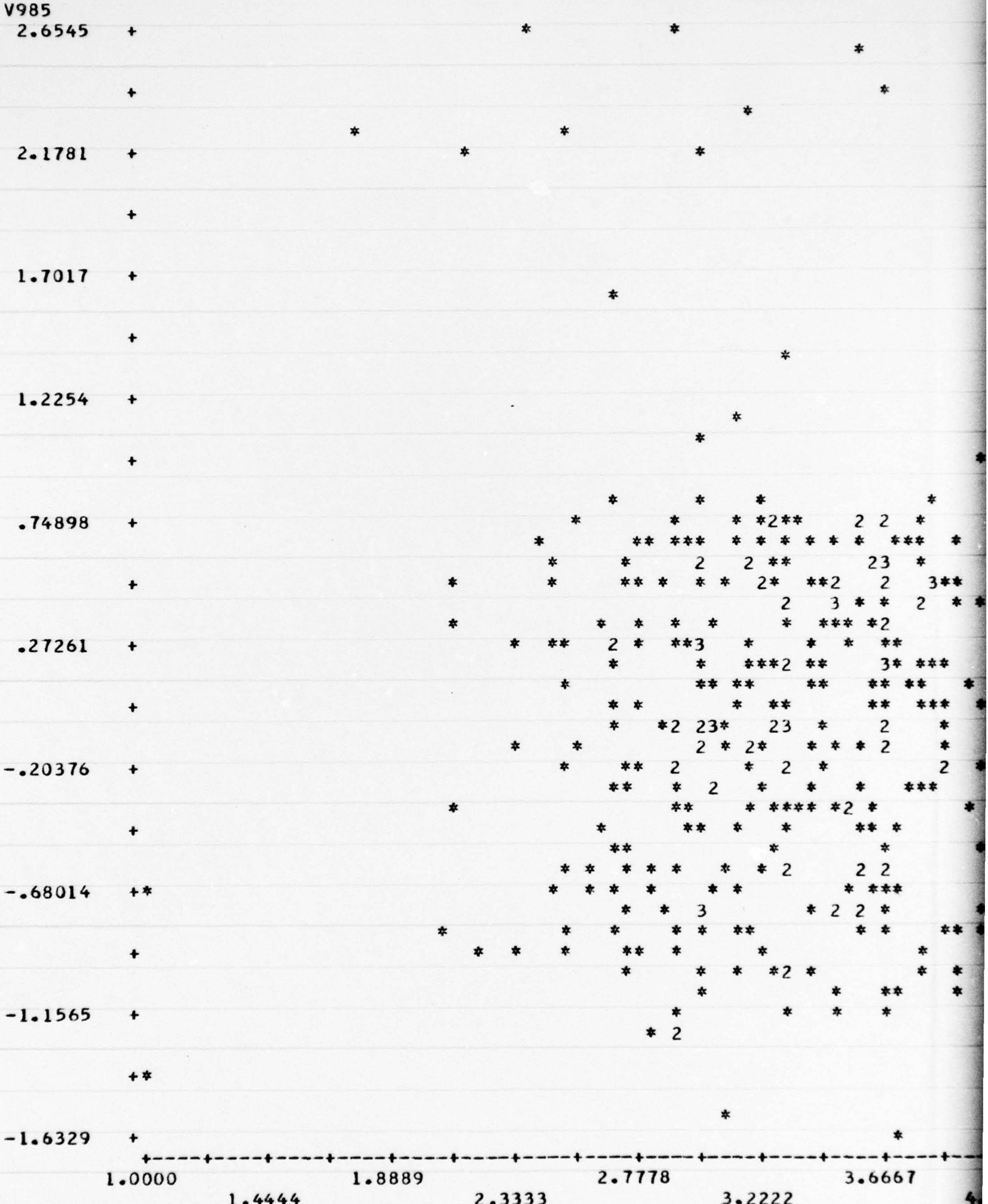

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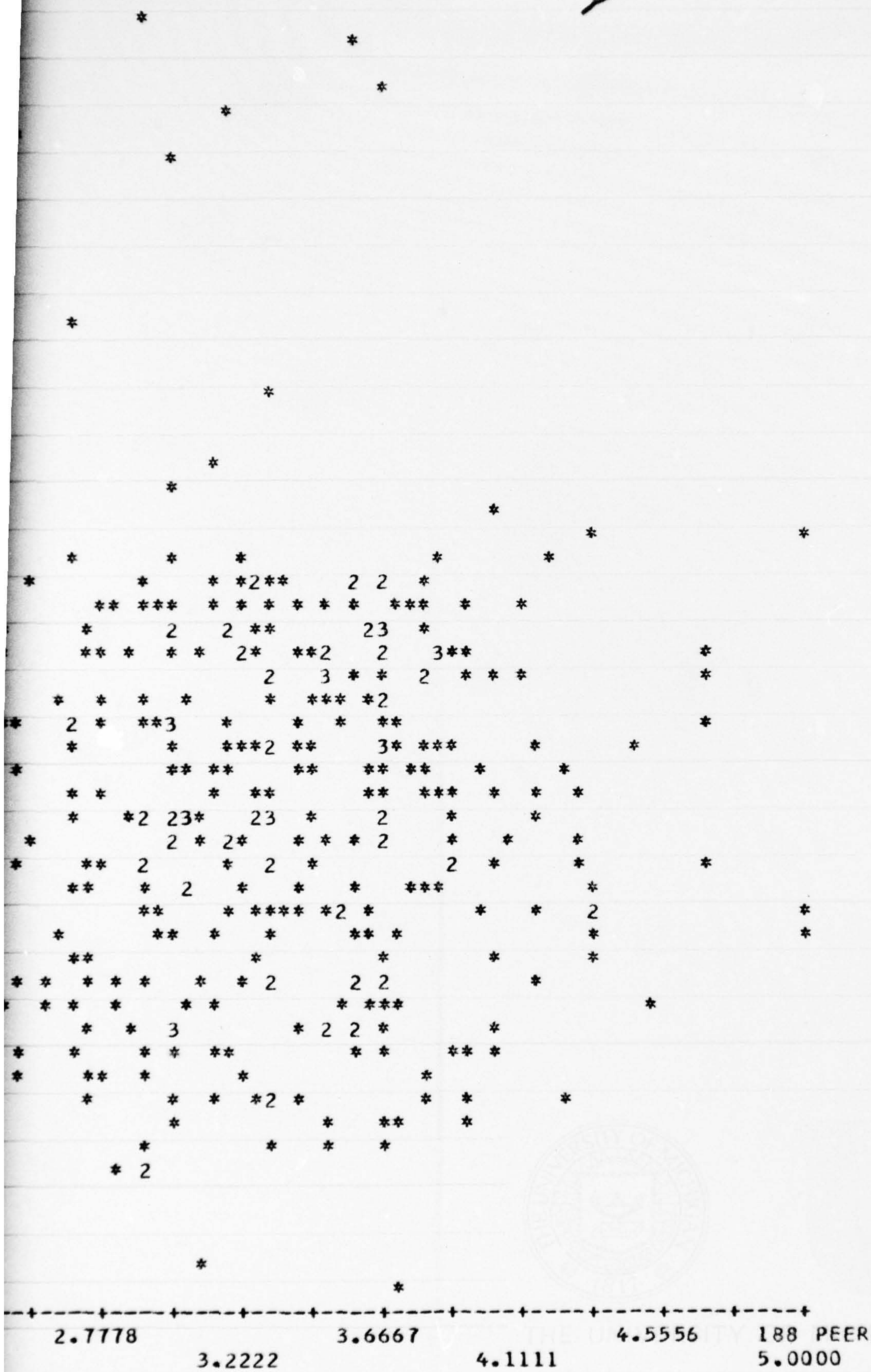

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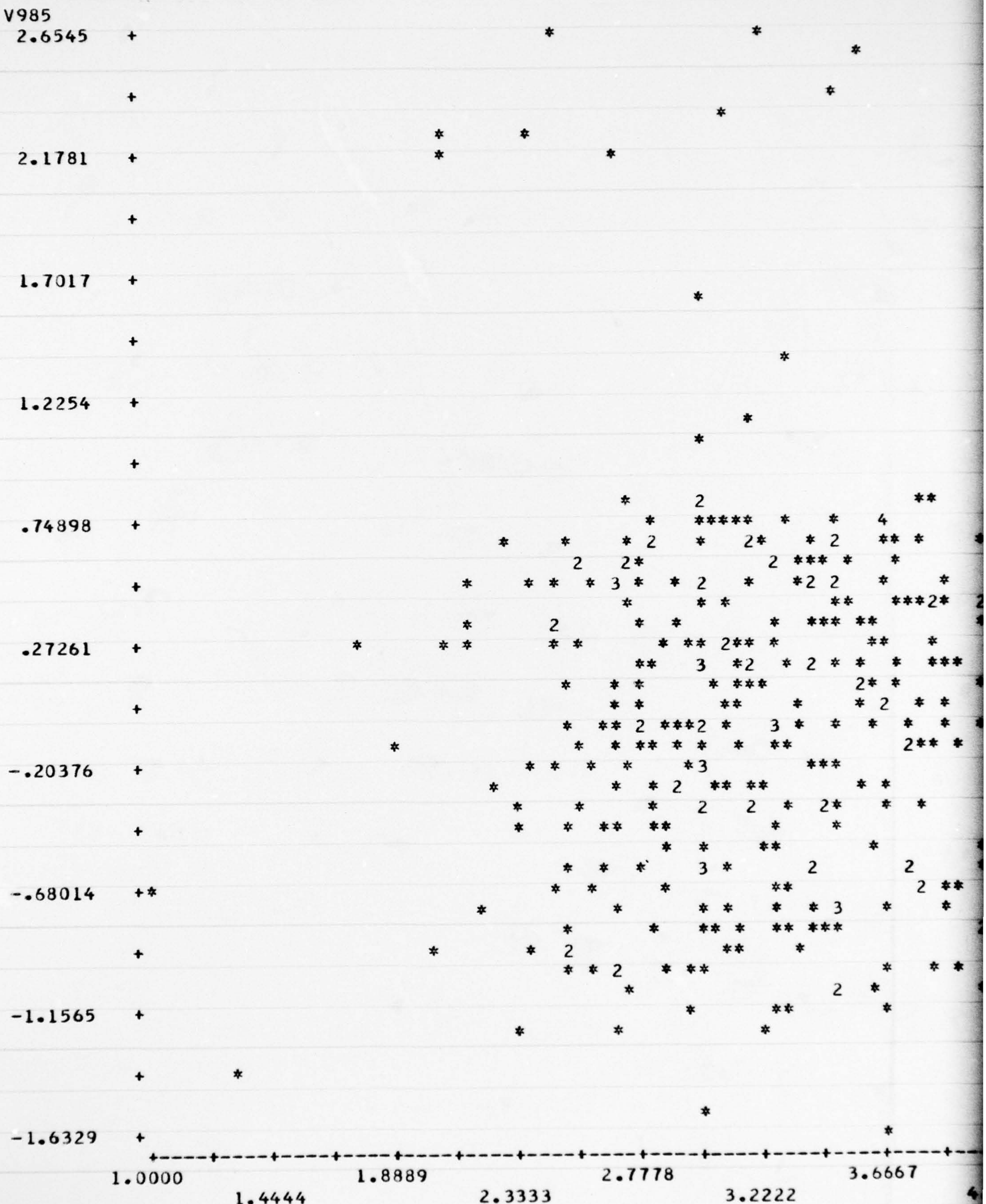

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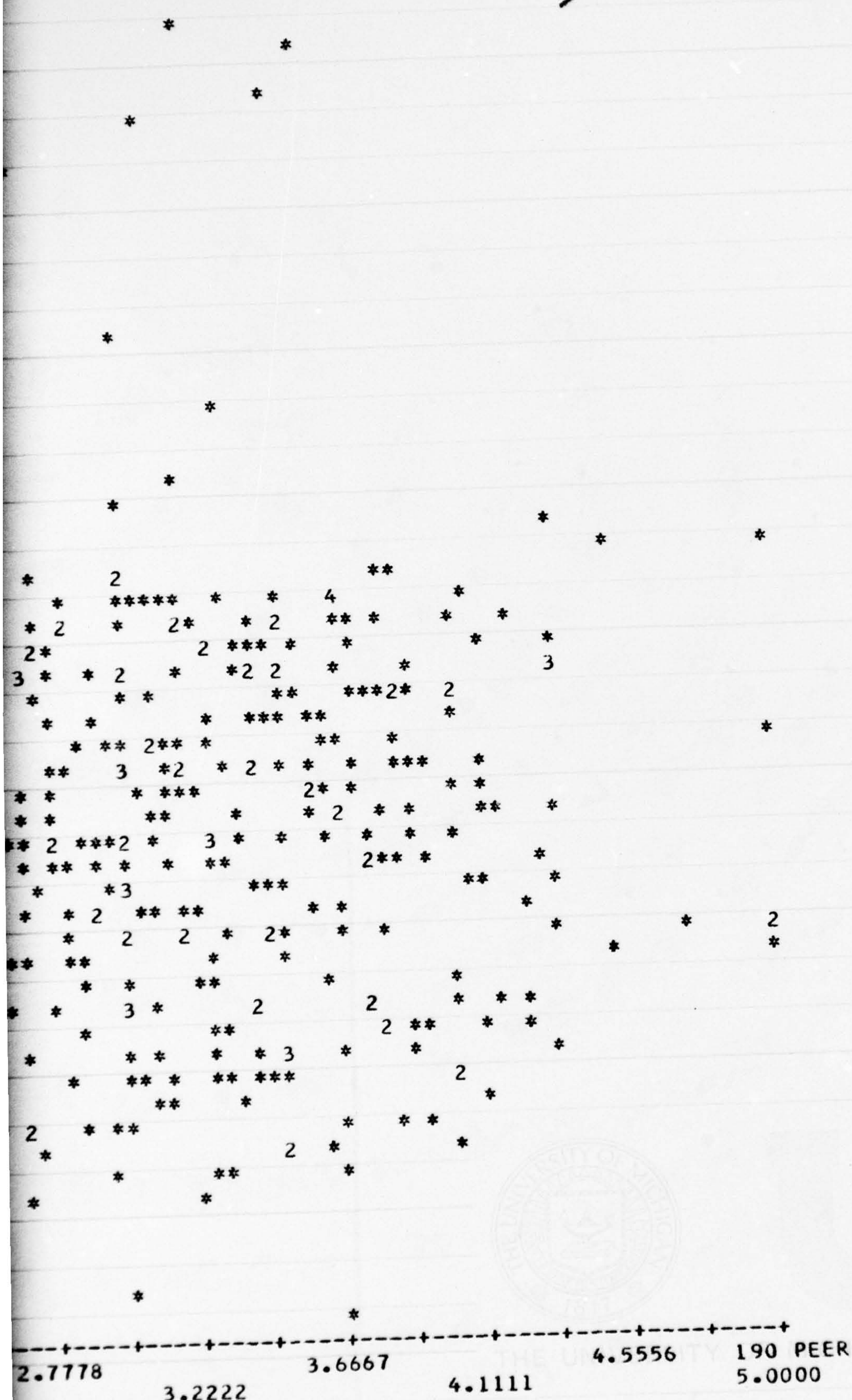

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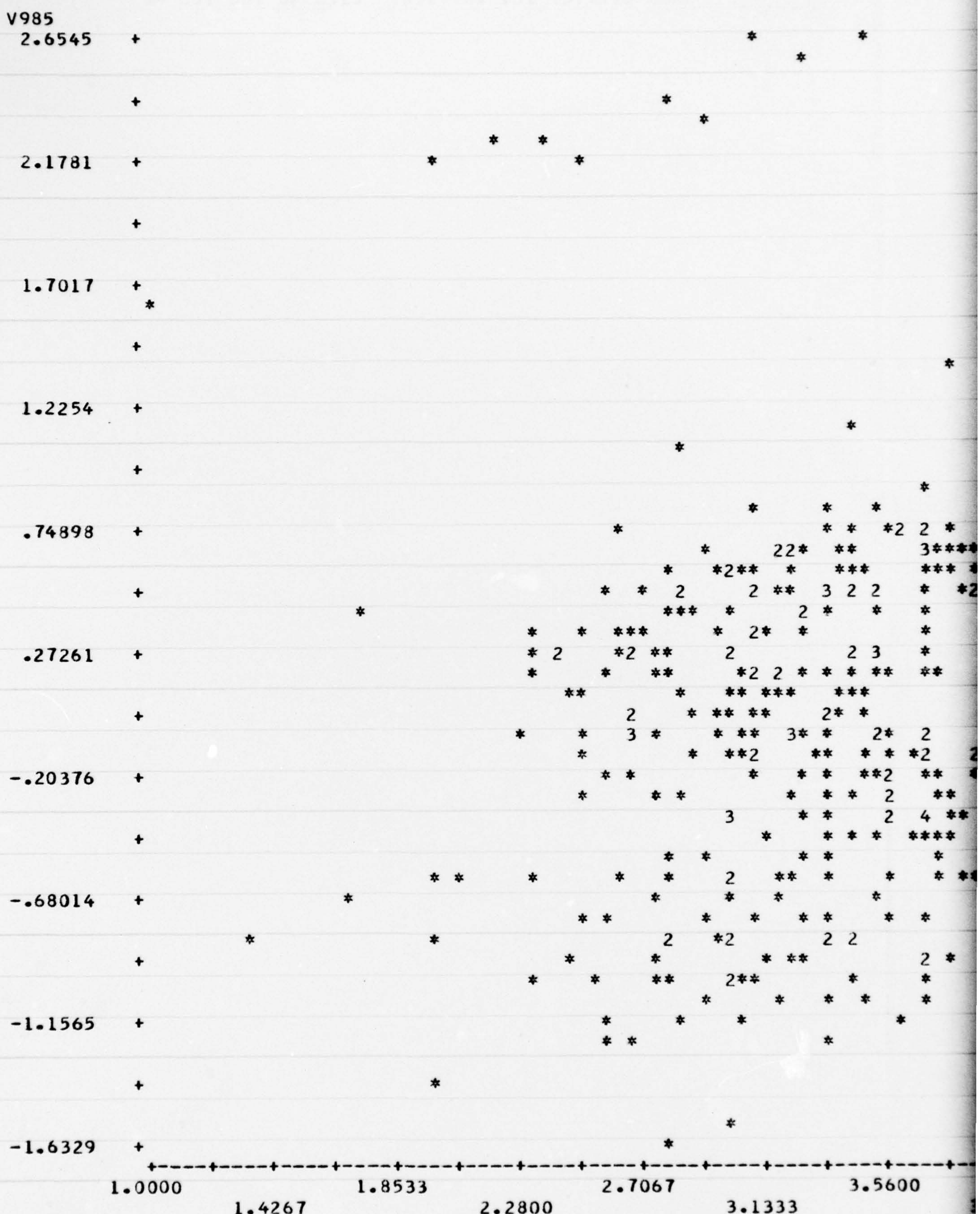

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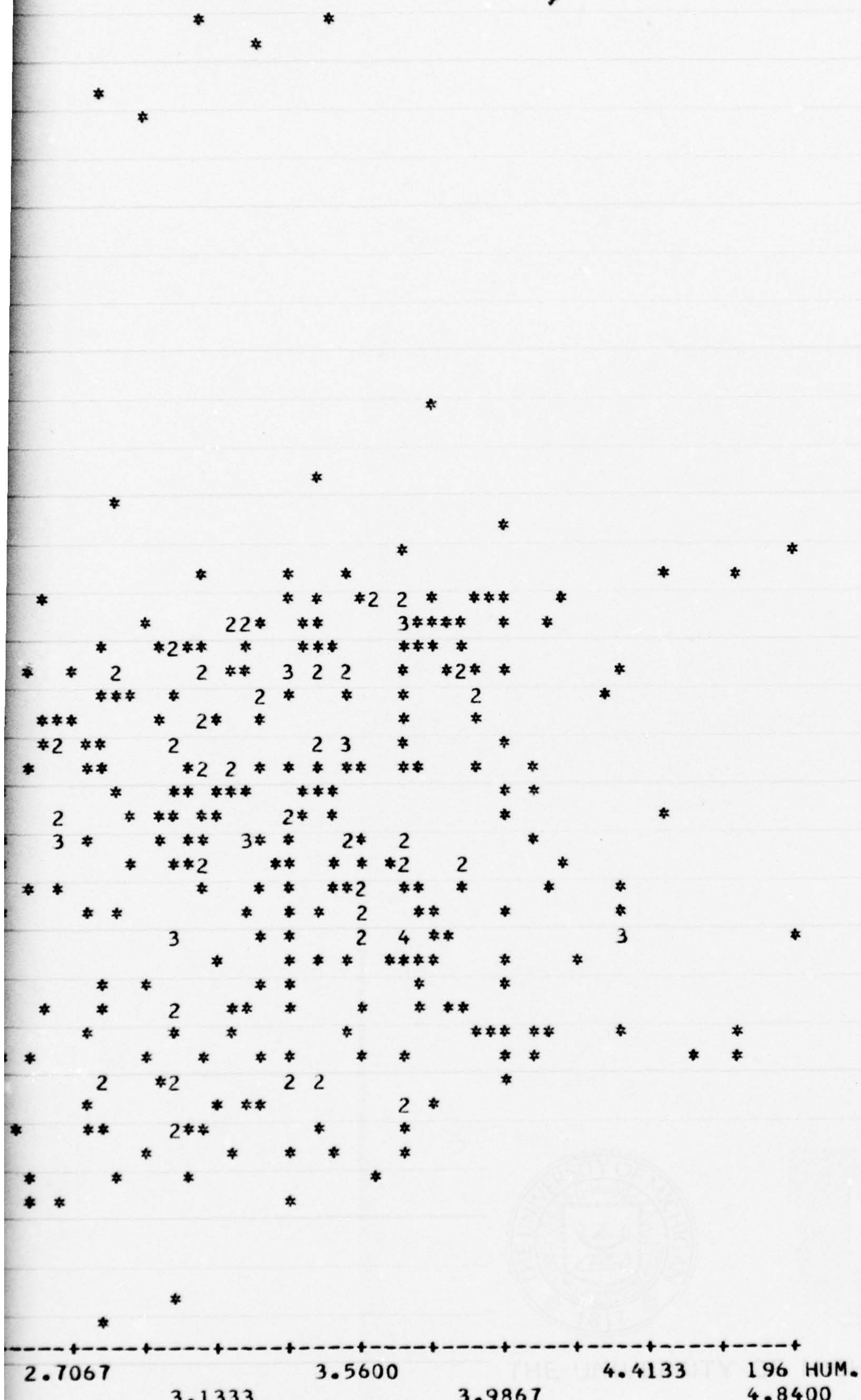

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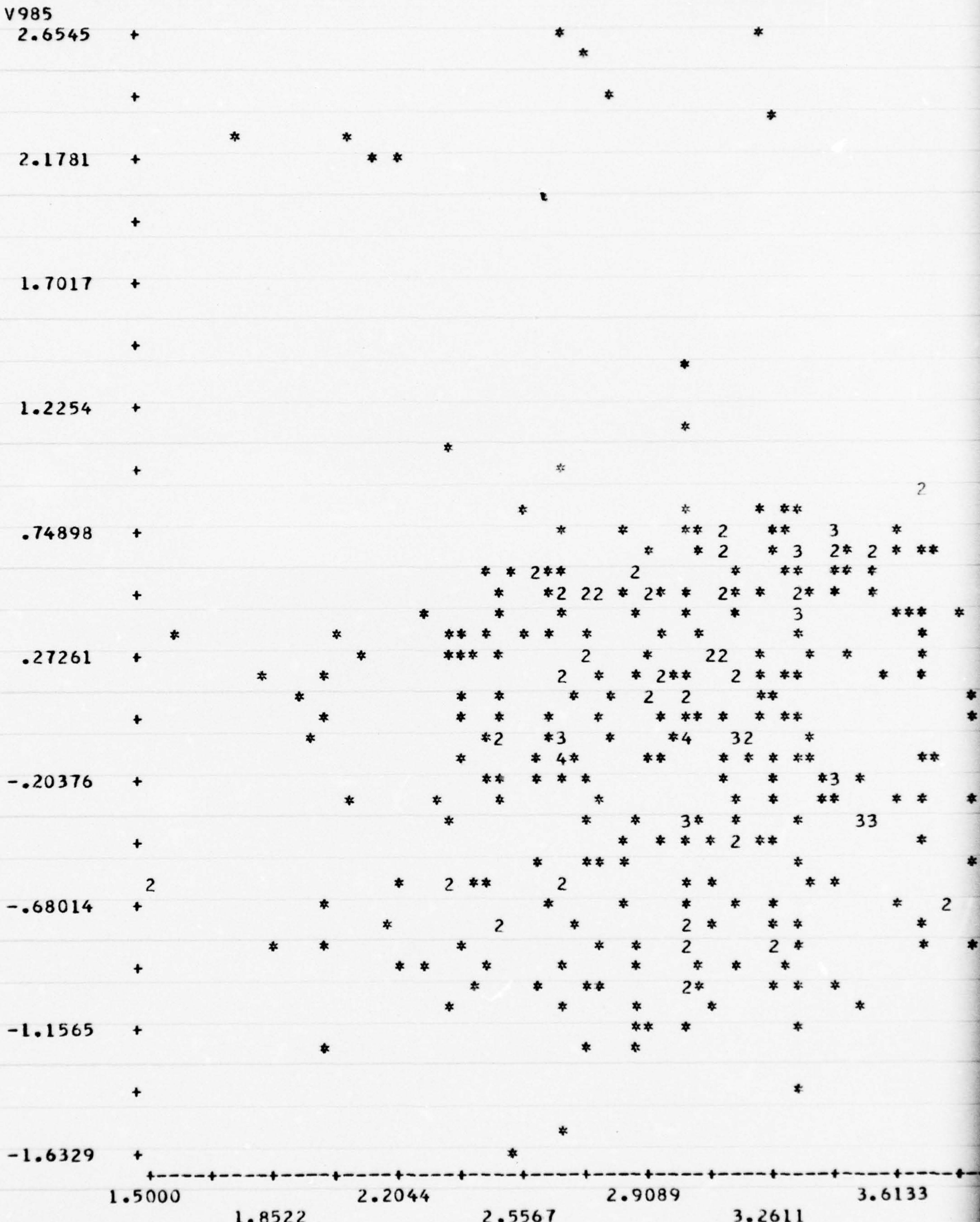

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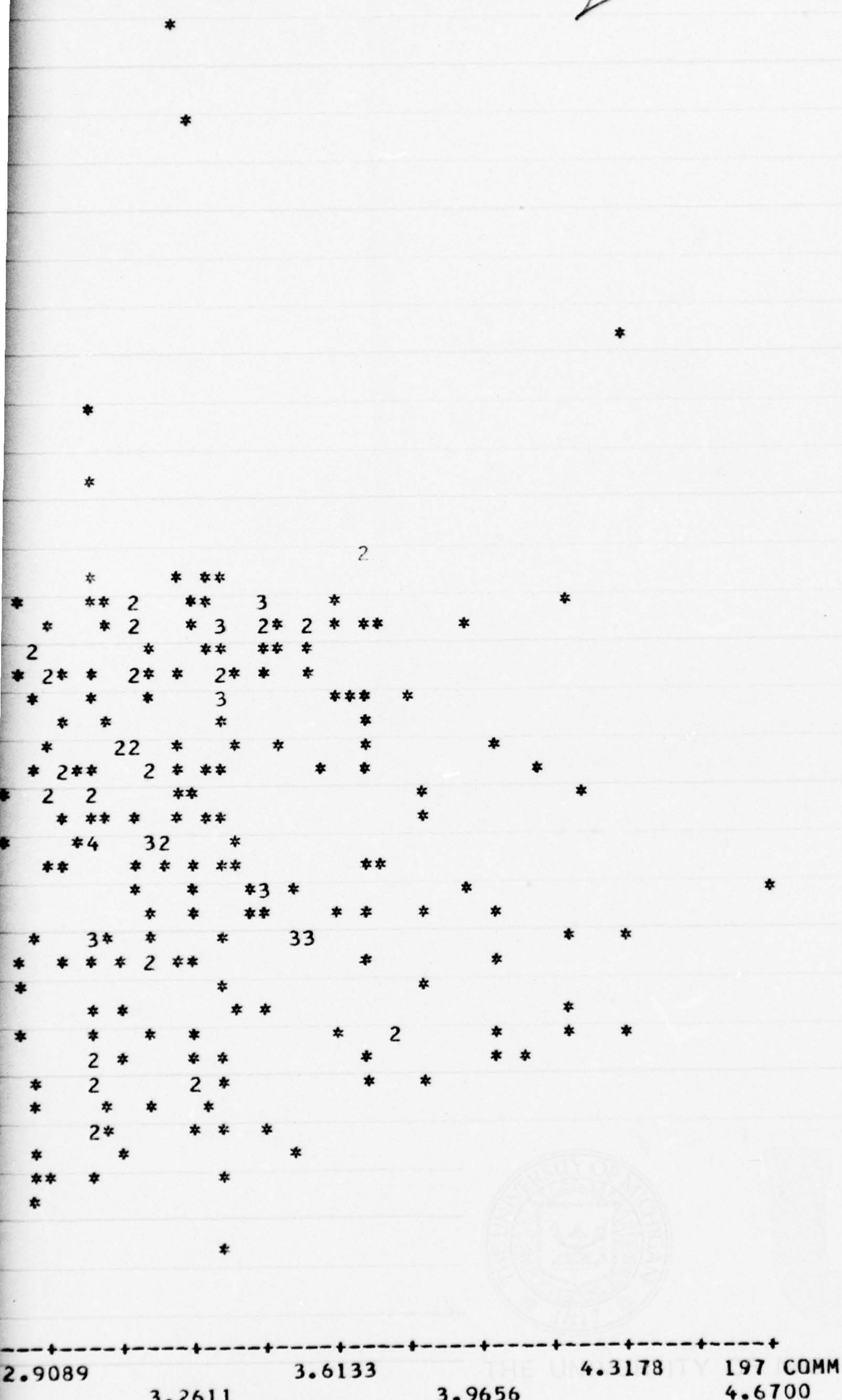

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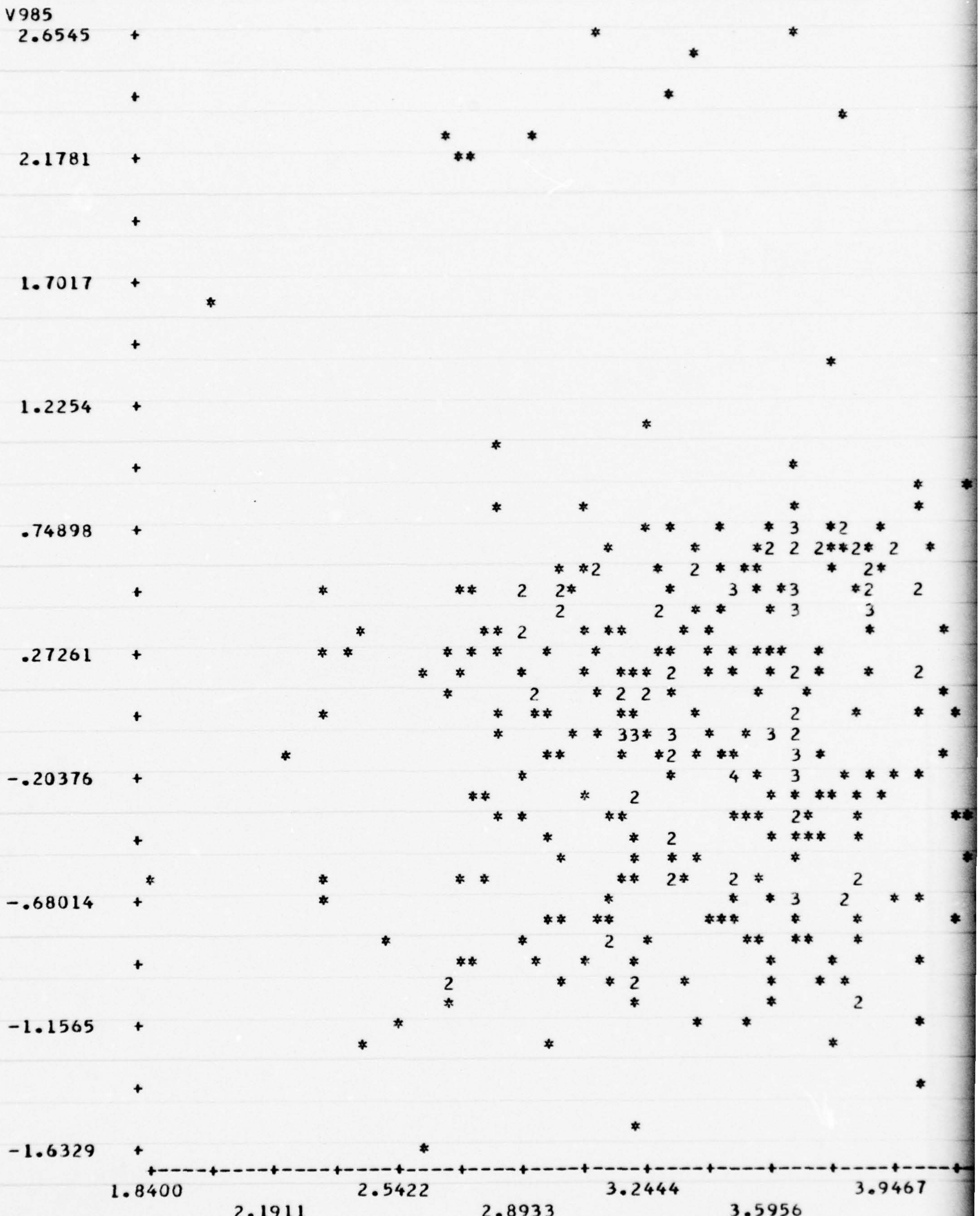

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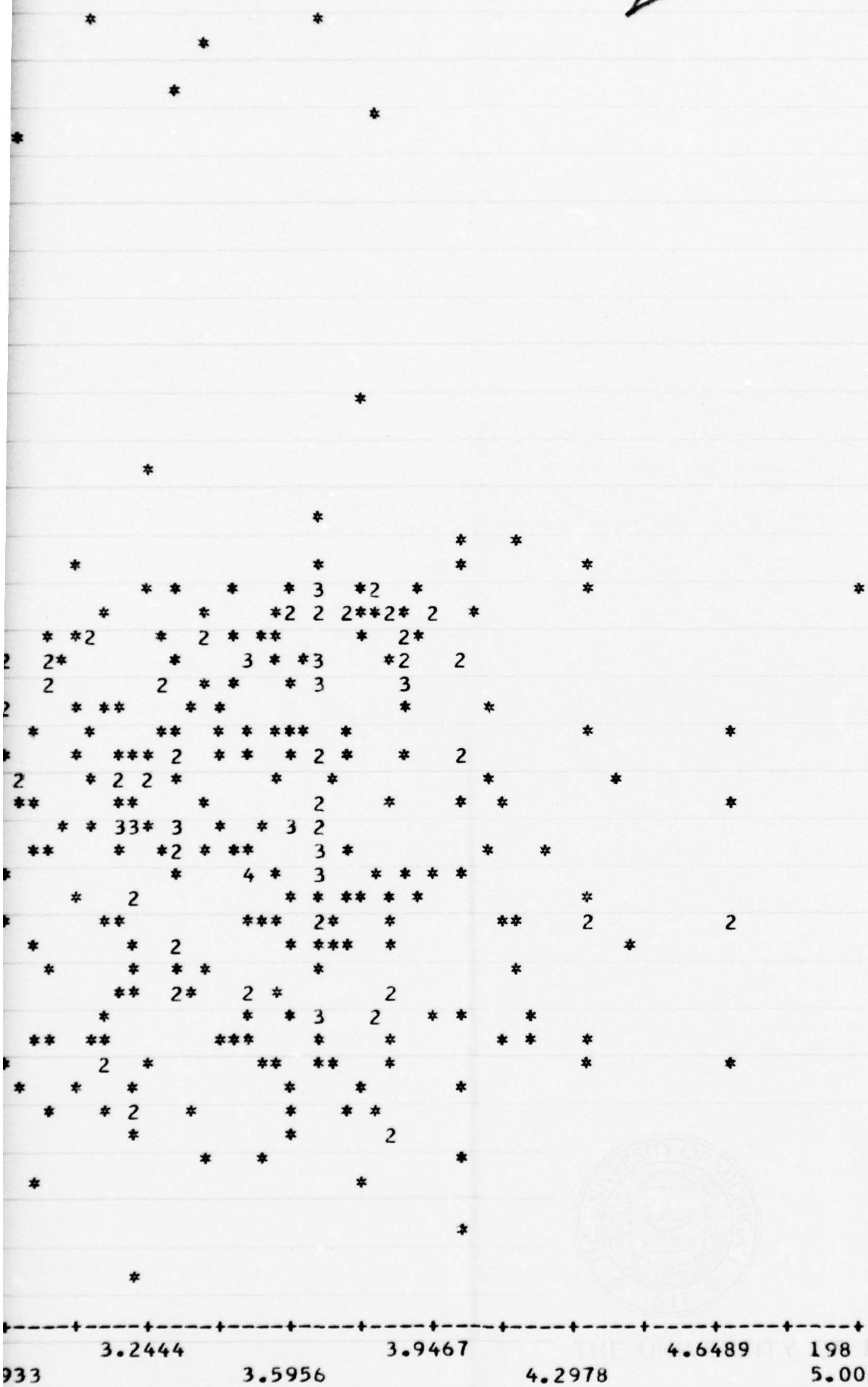

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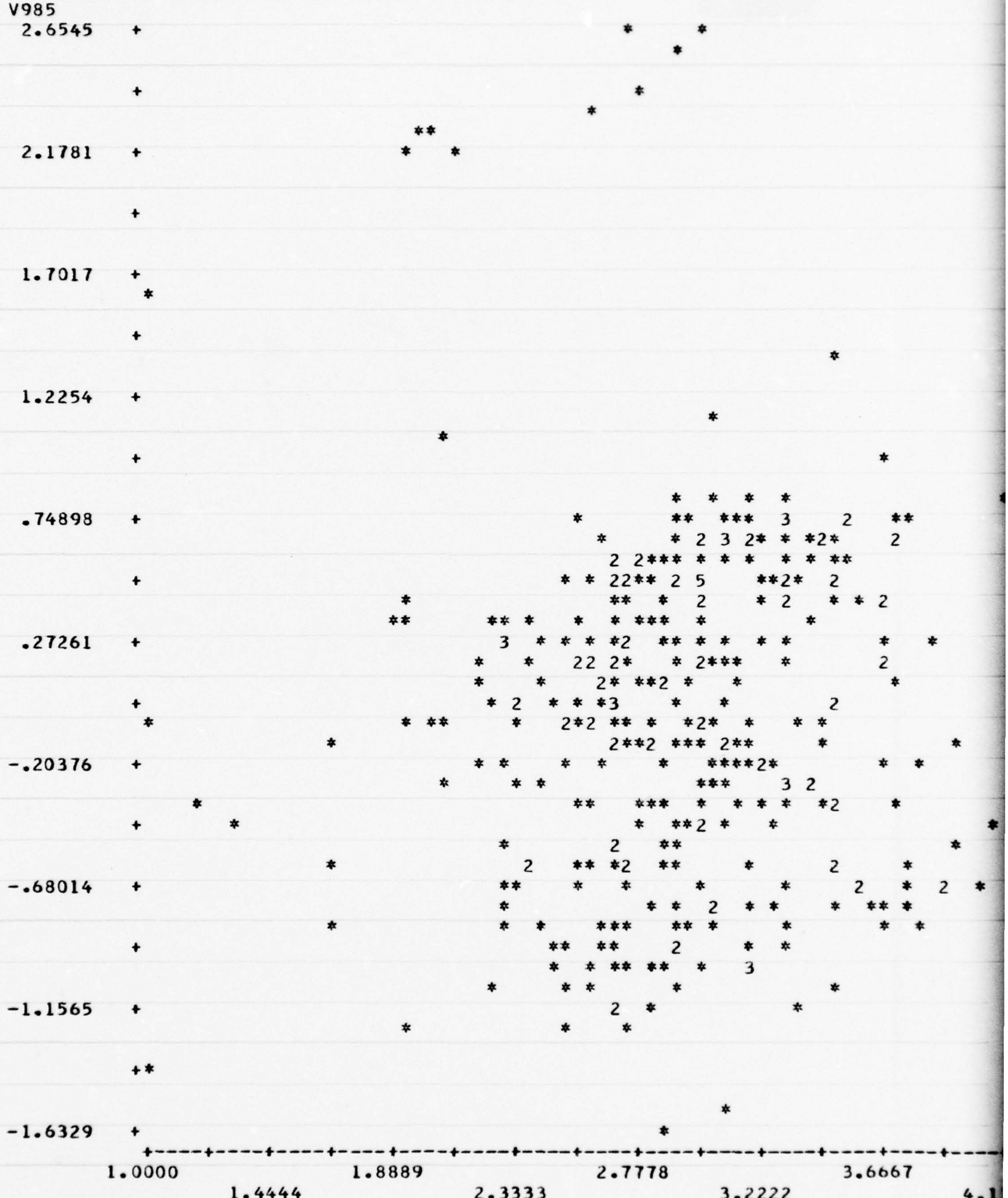

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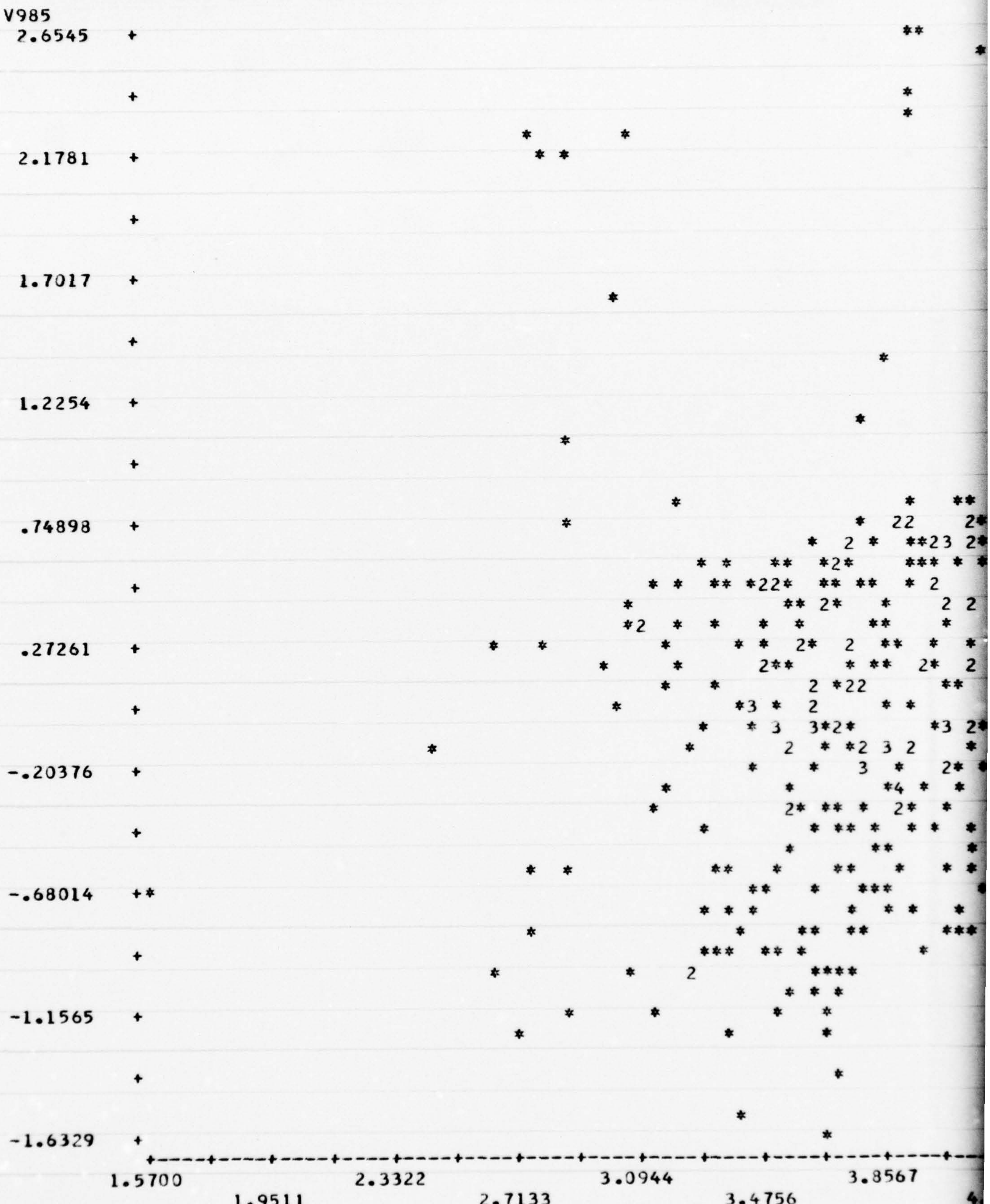

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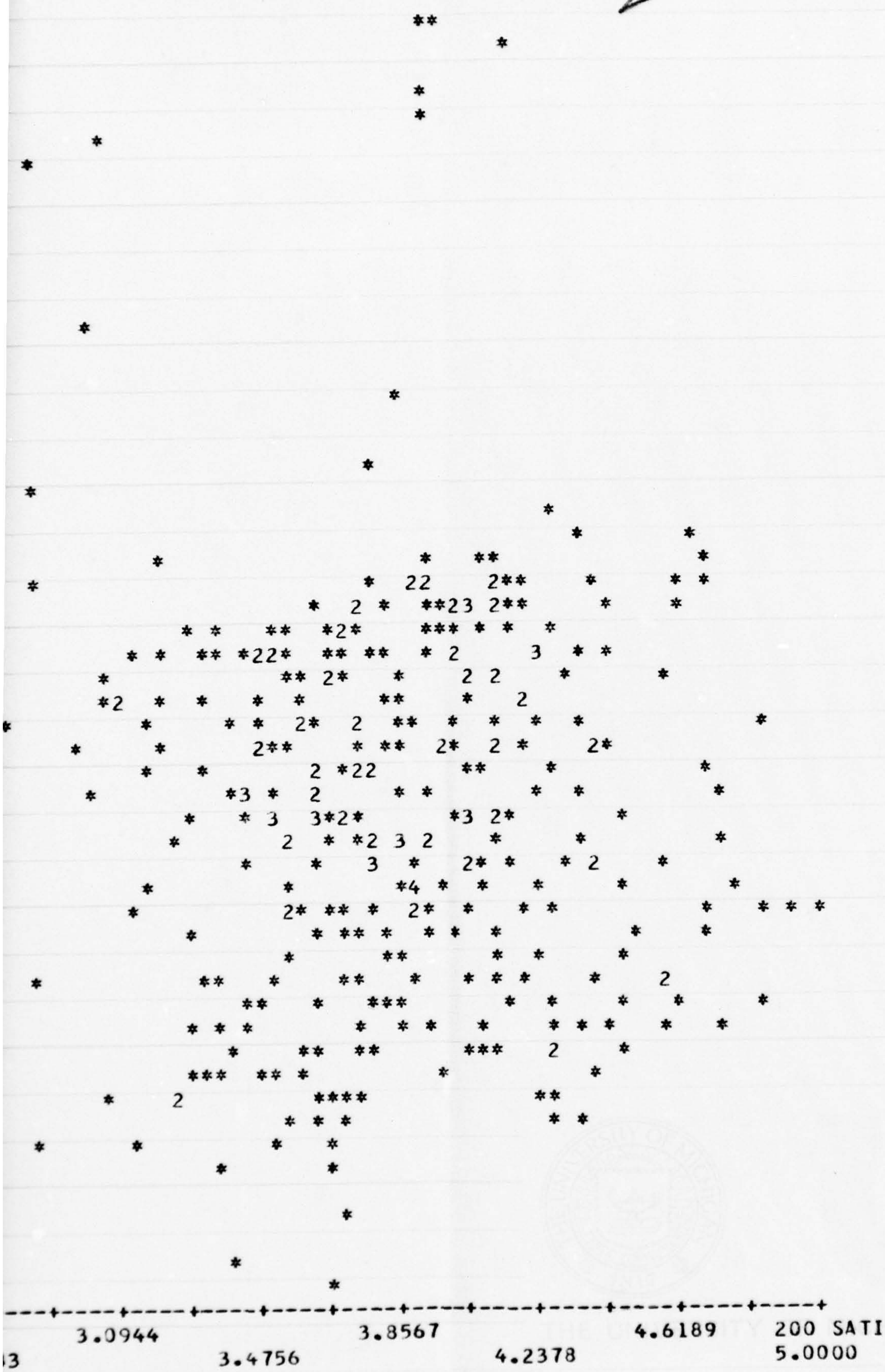

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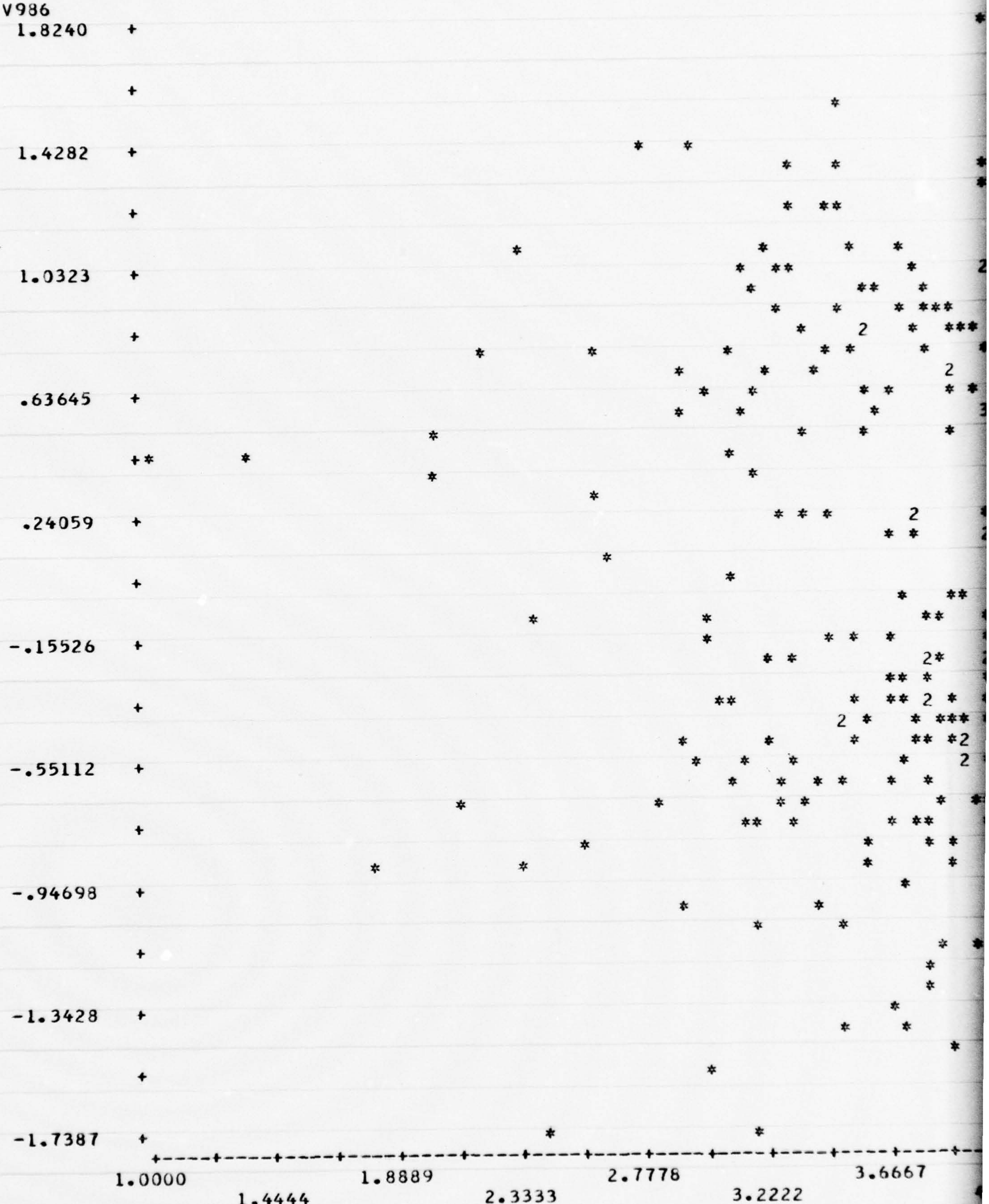

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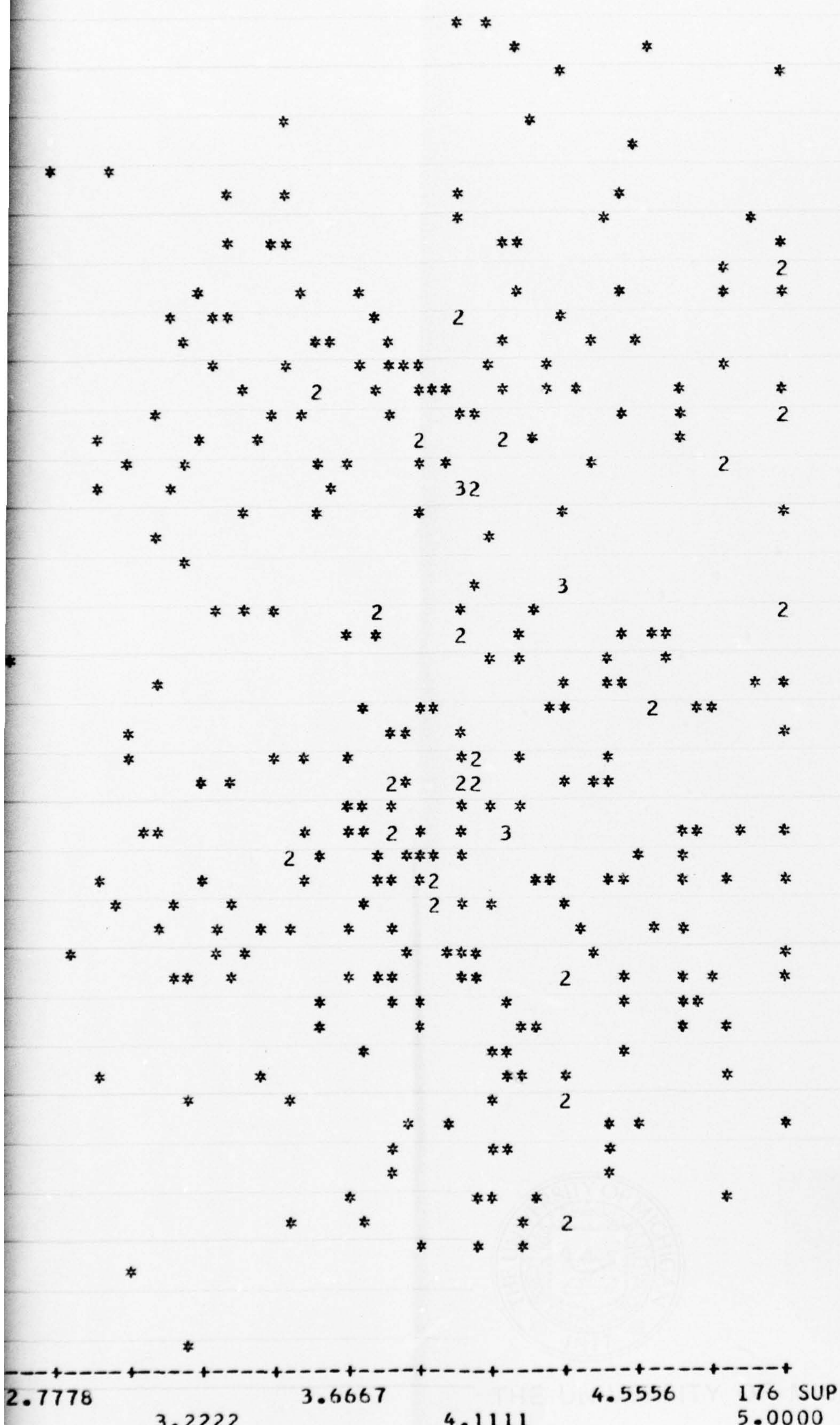

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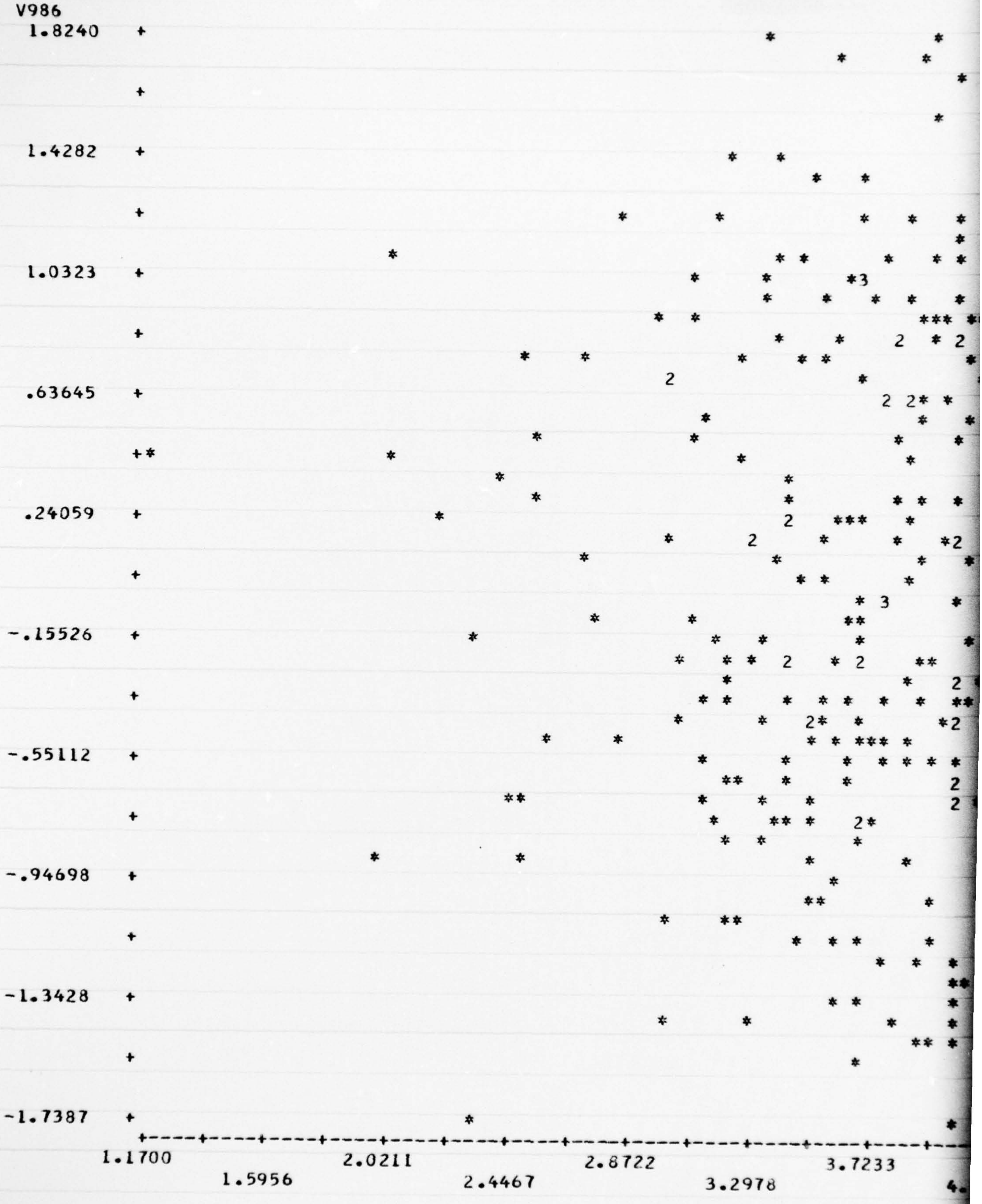

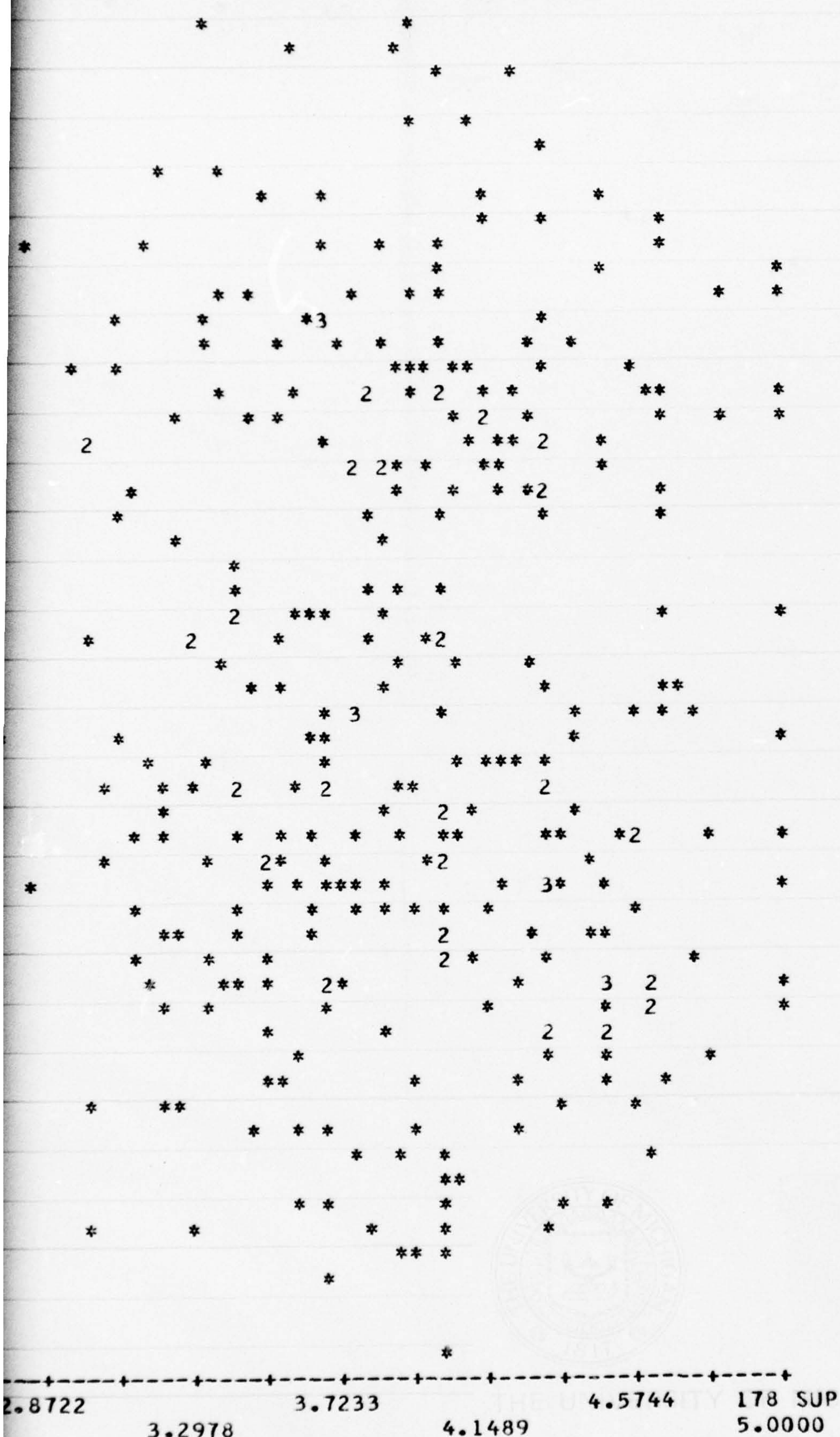
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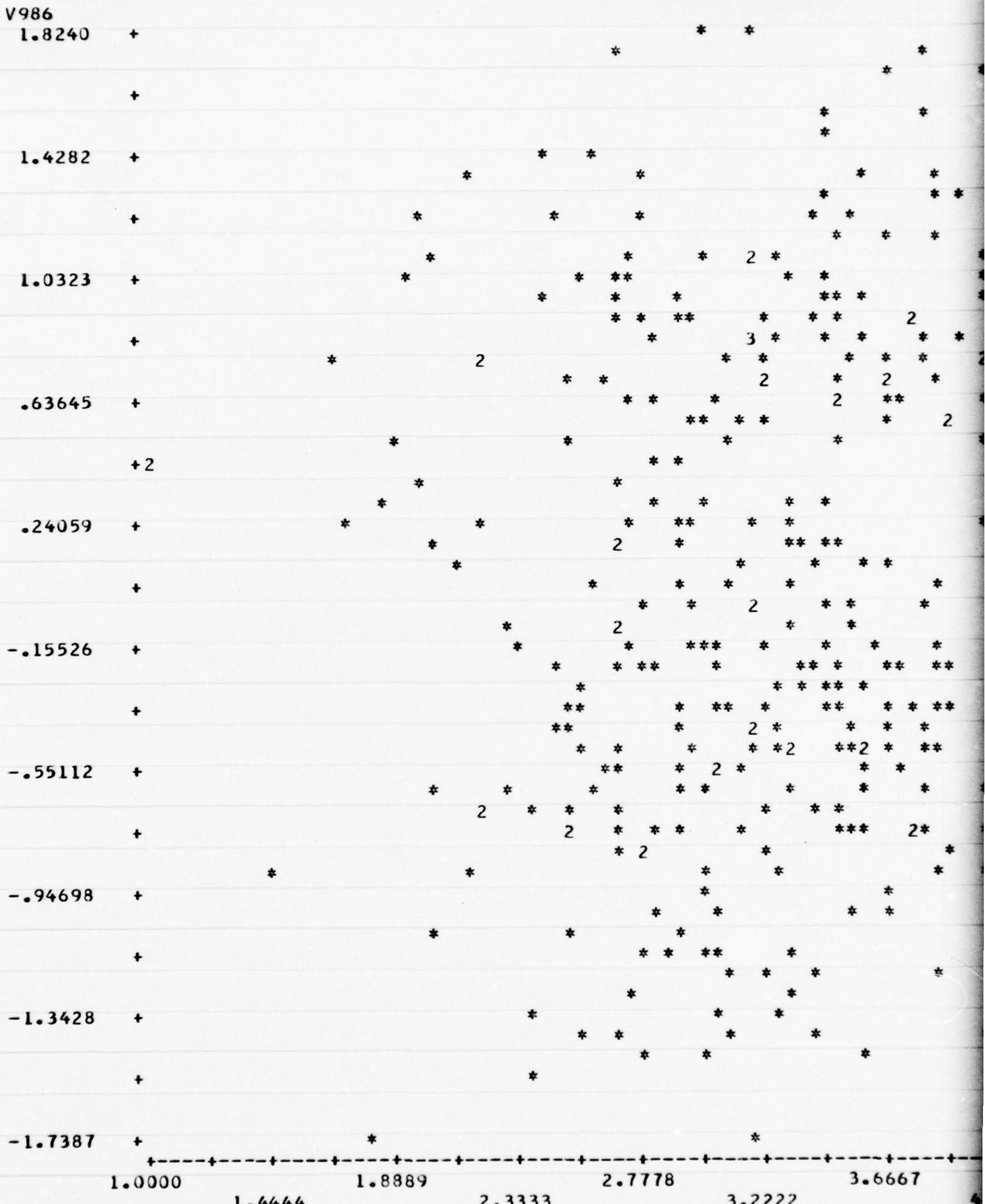

B-200

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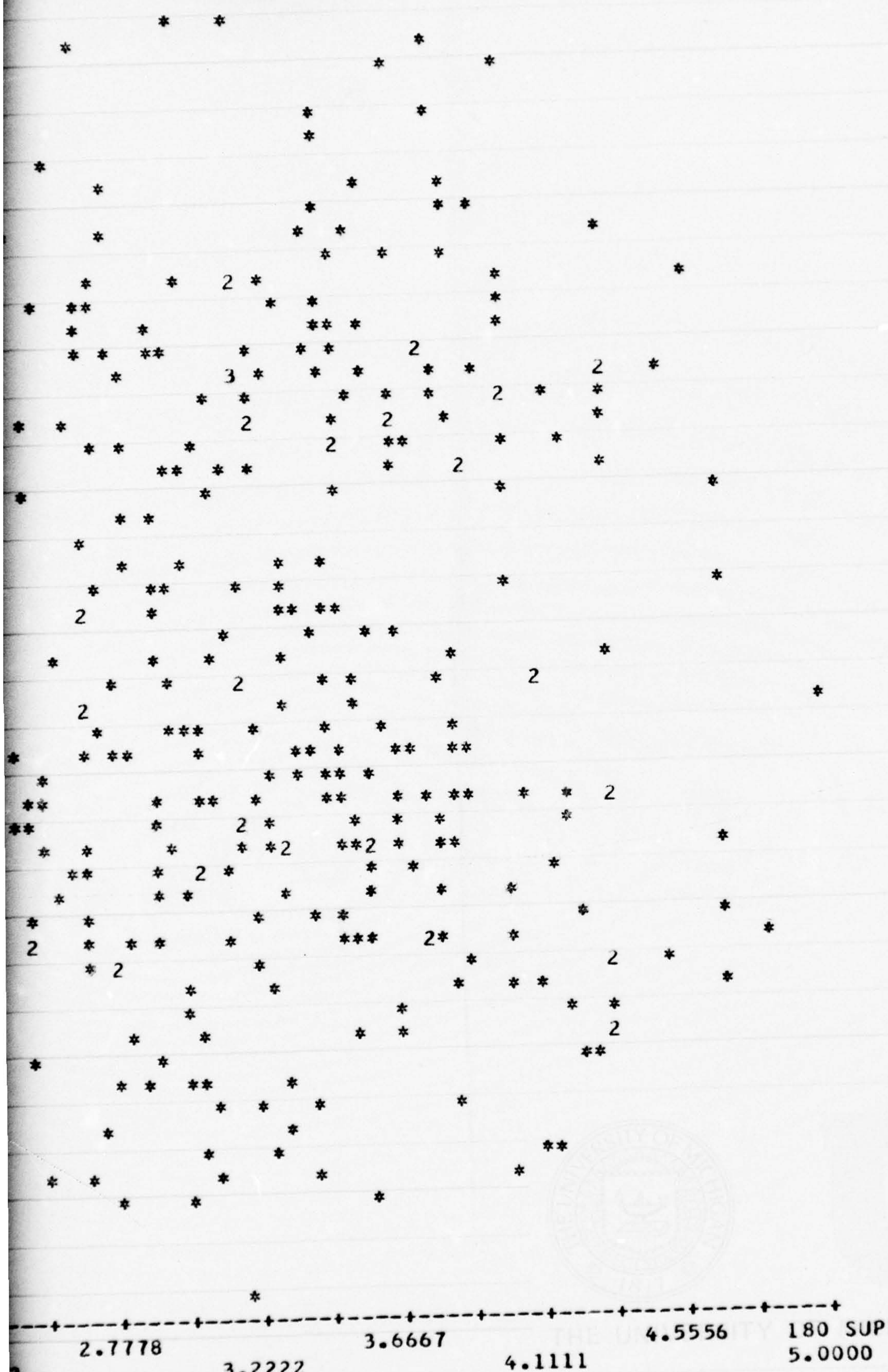

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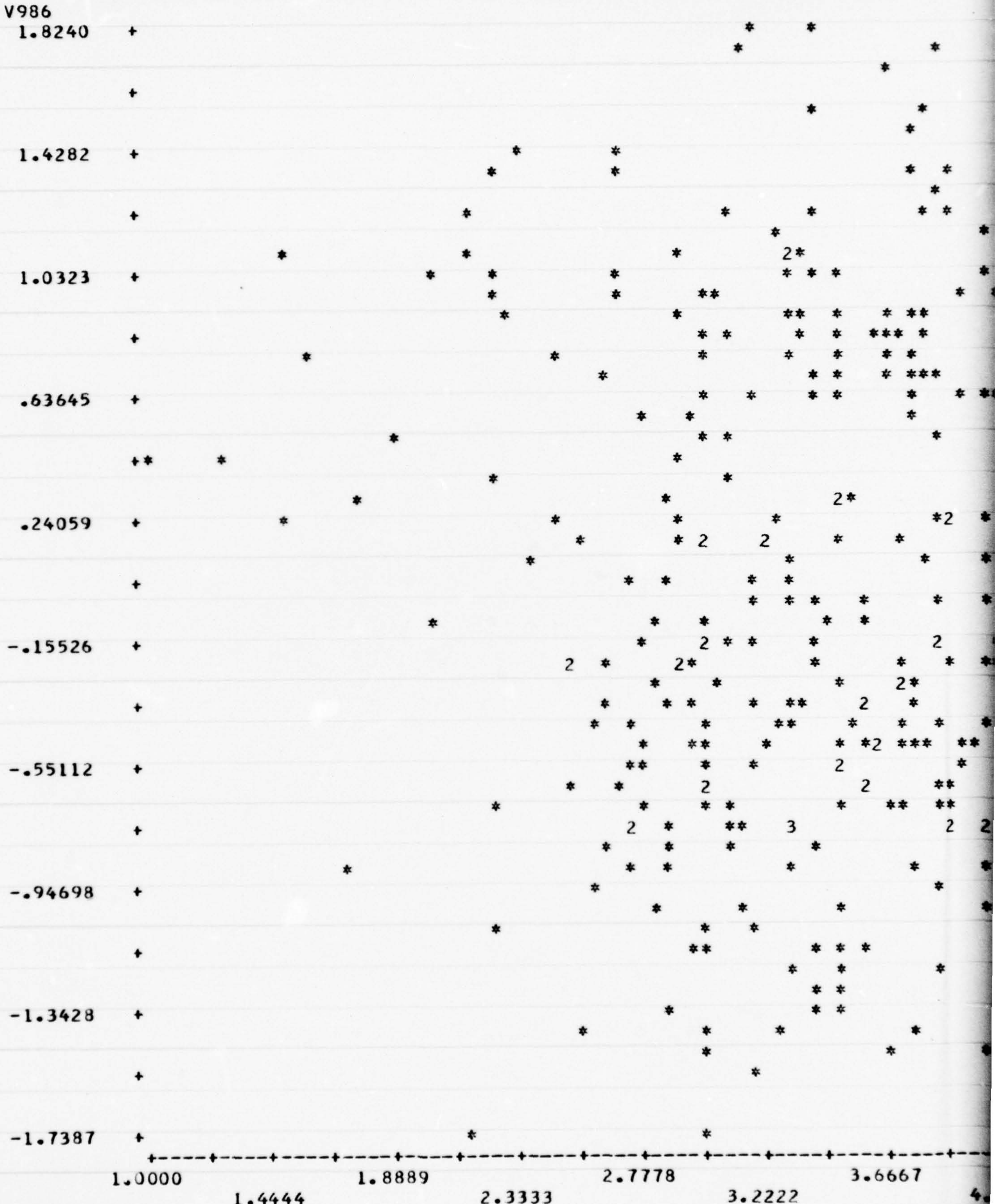

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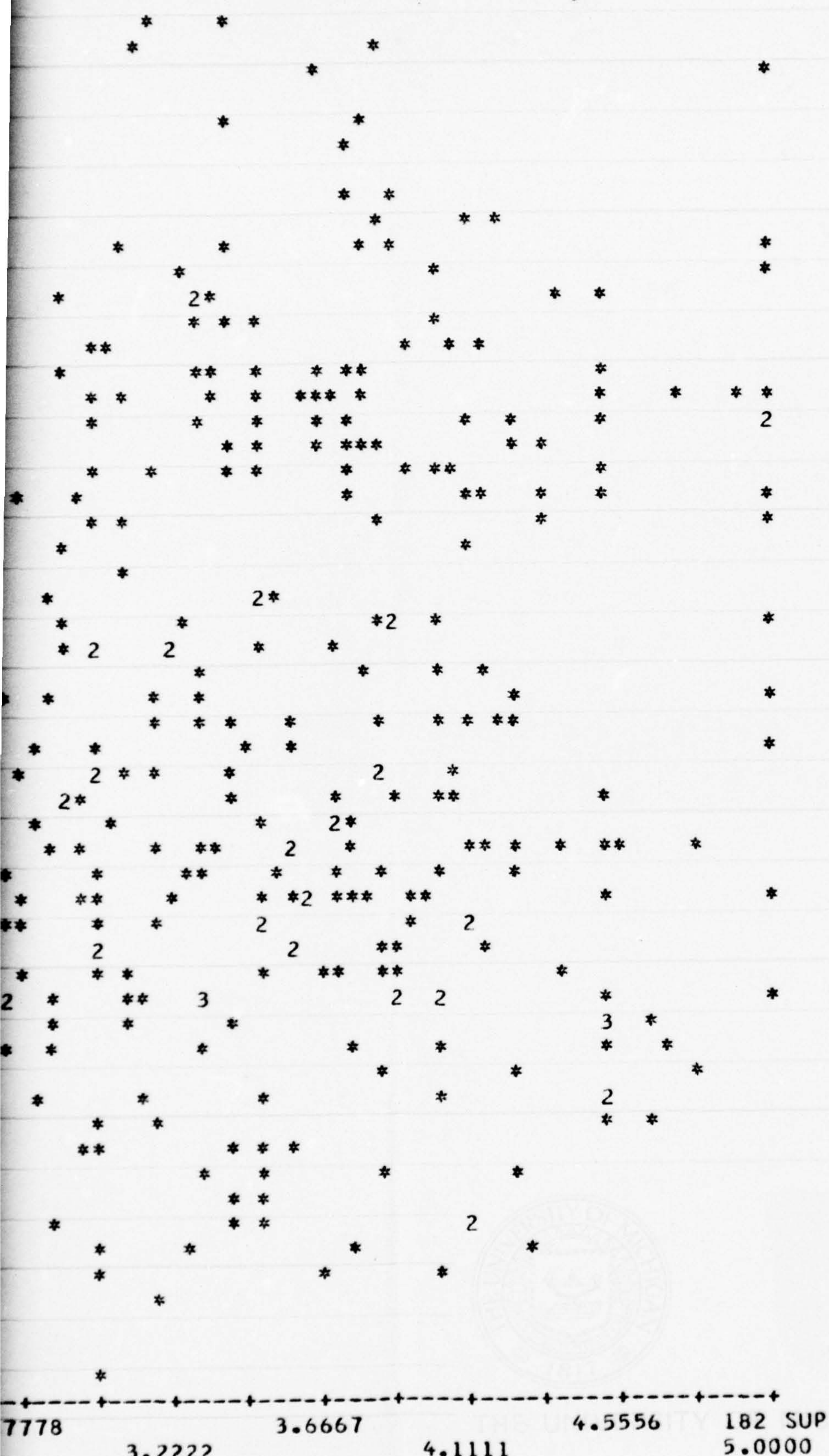

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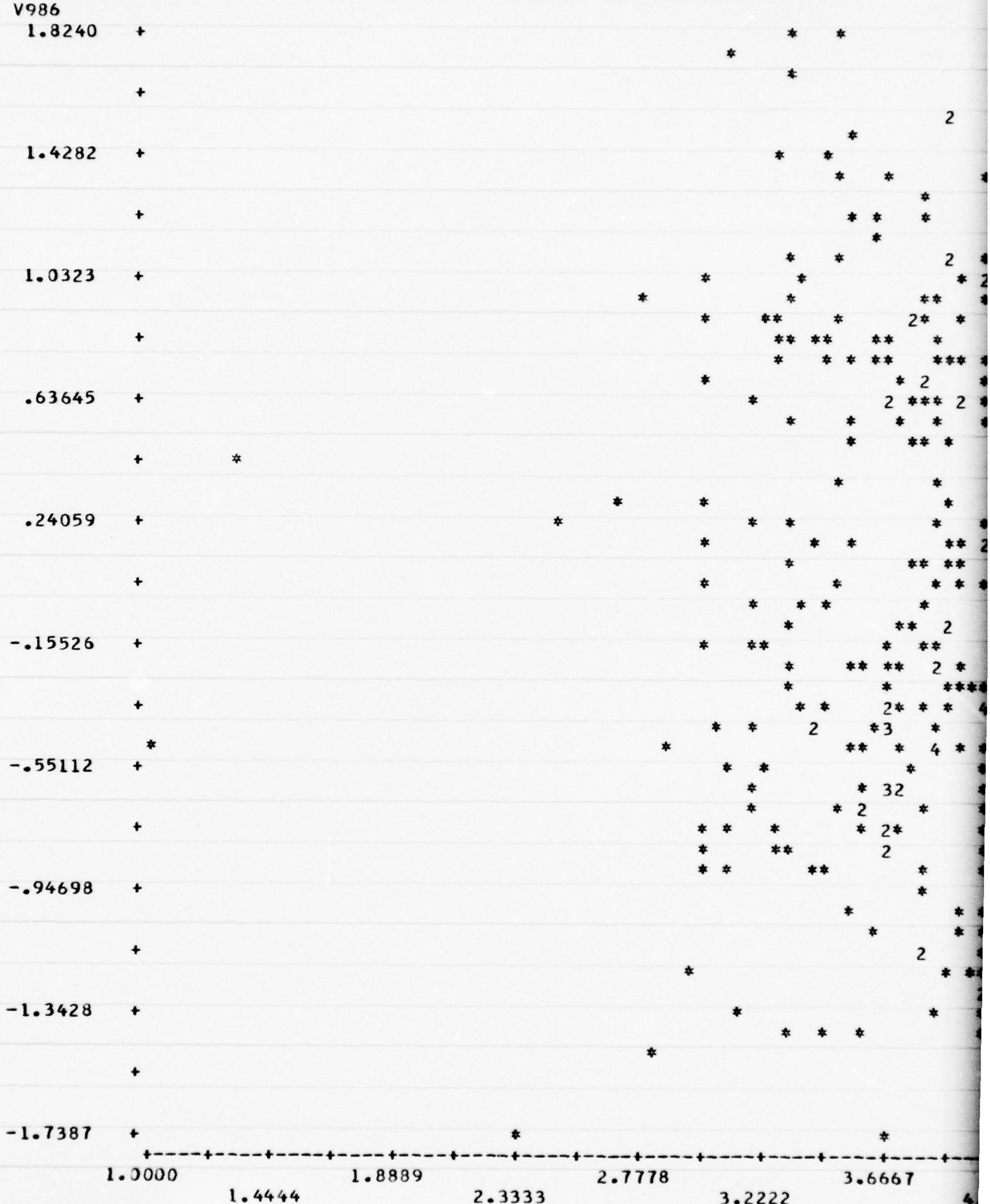

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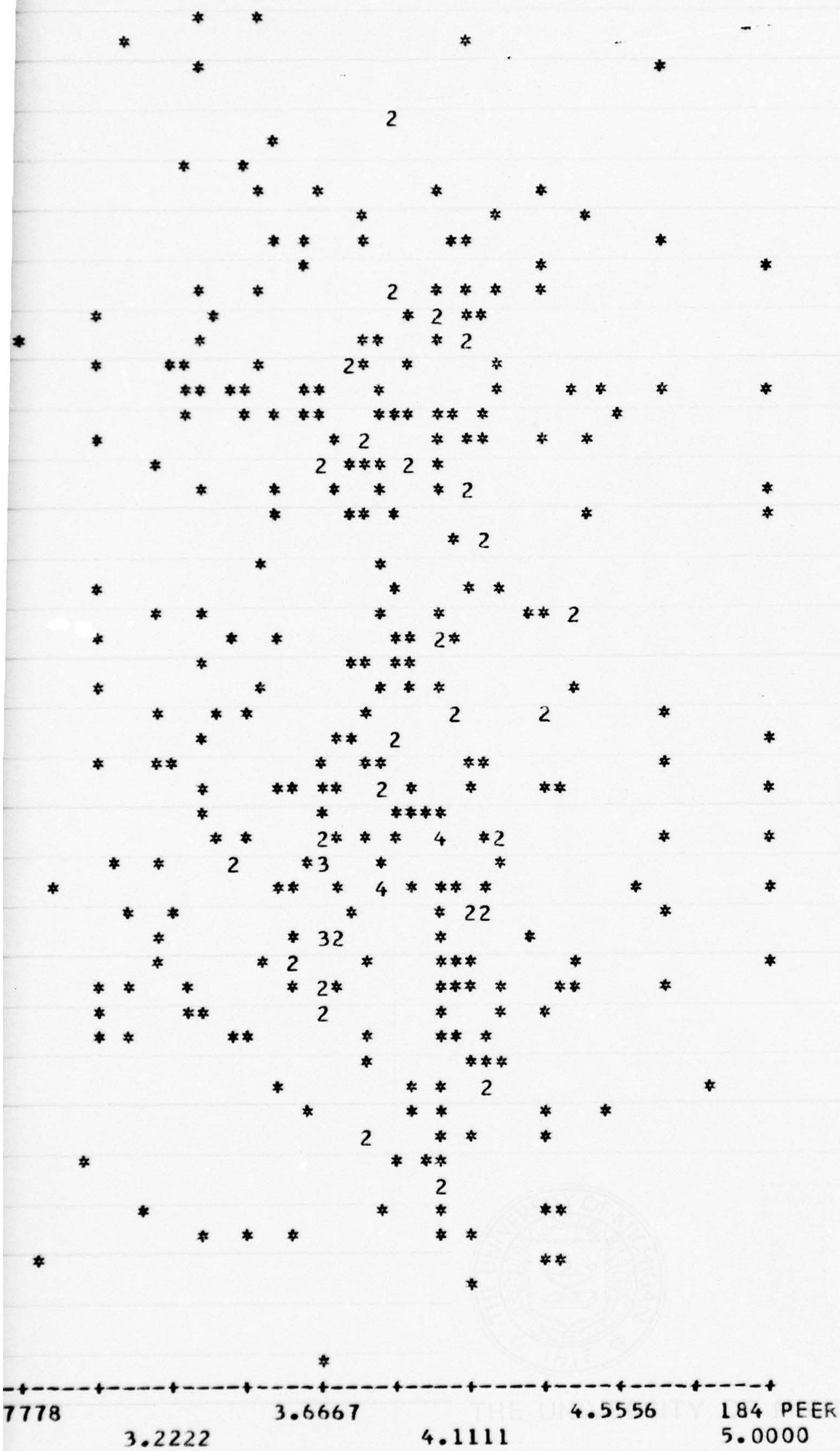

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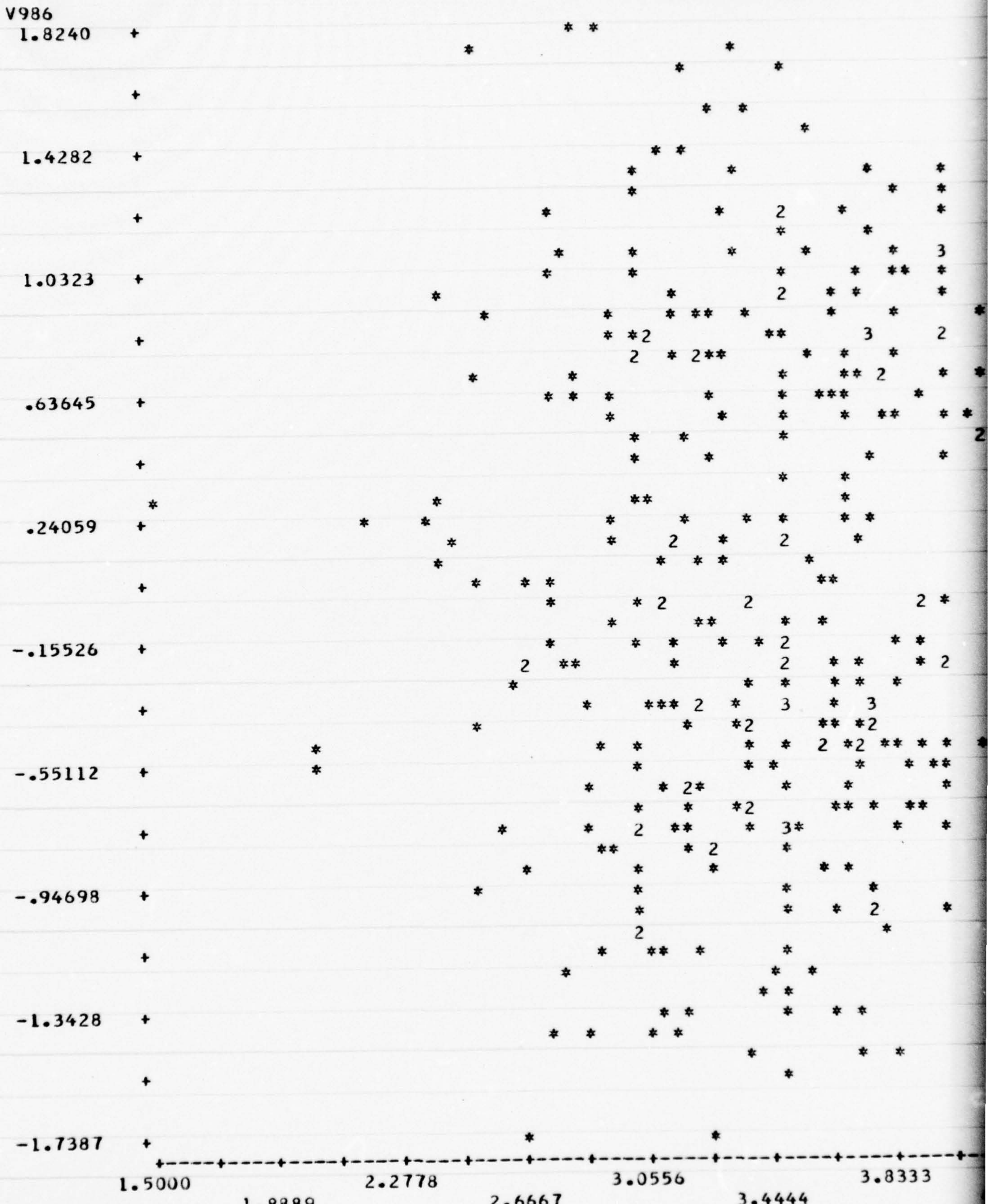

B-203

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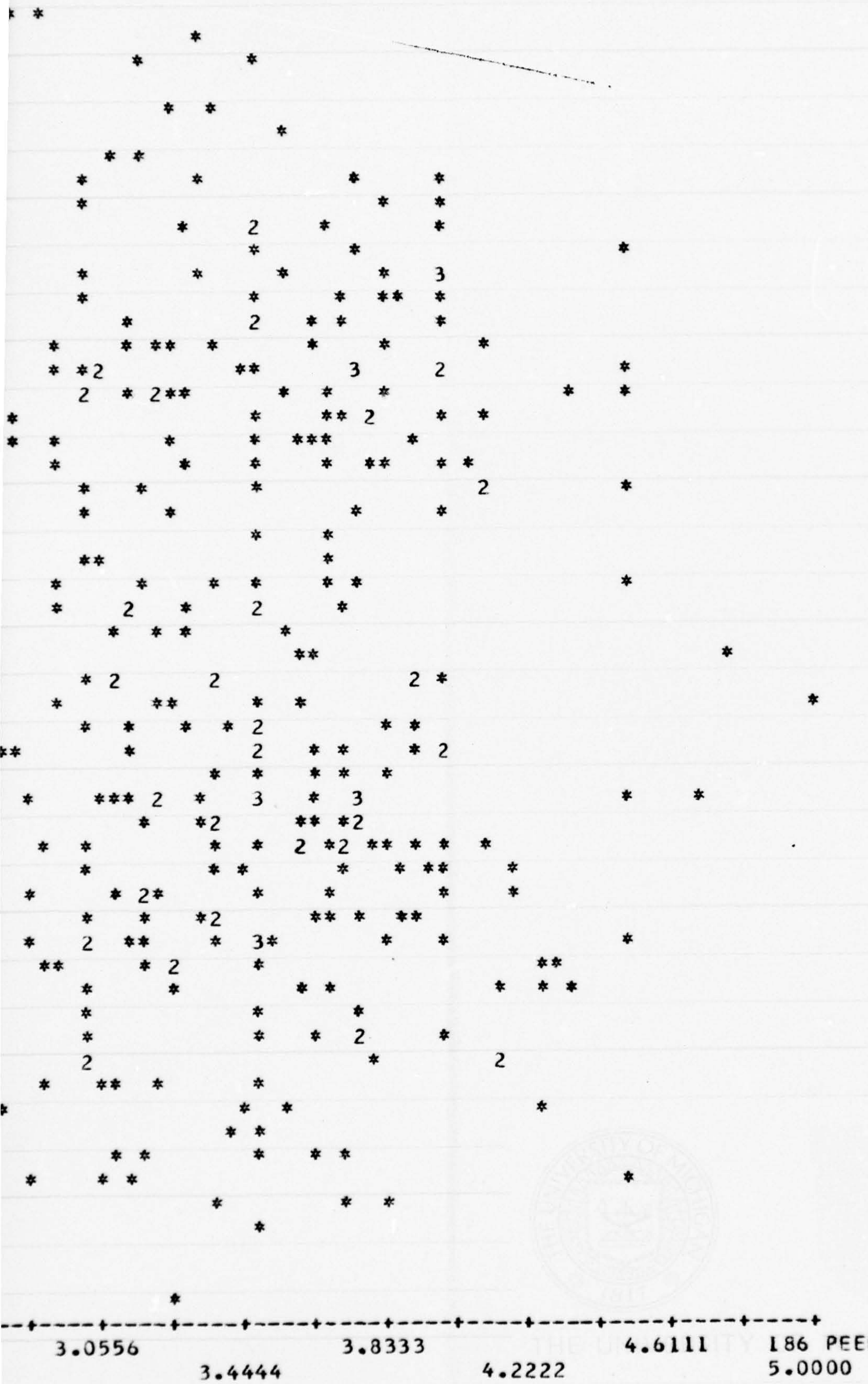

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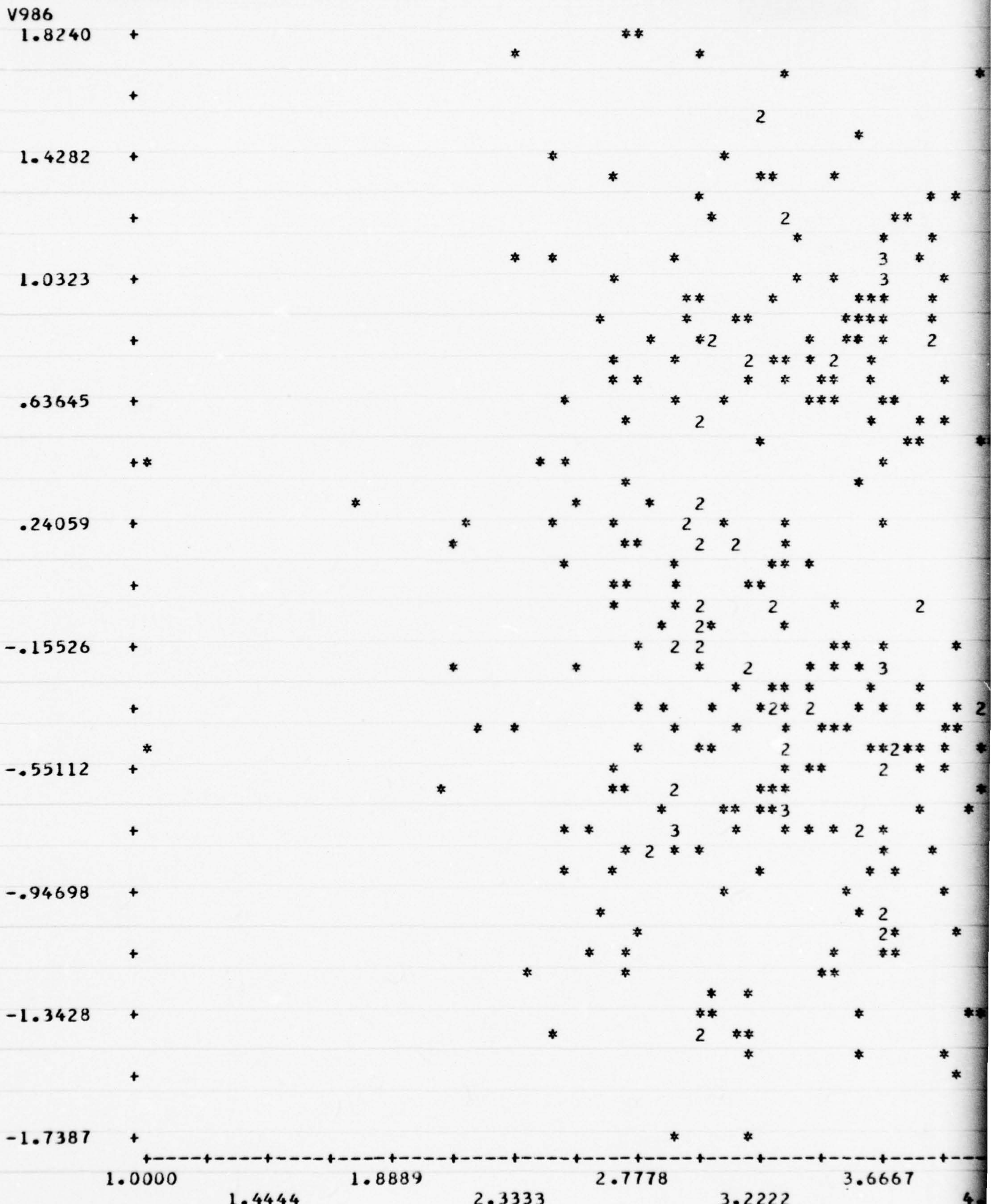

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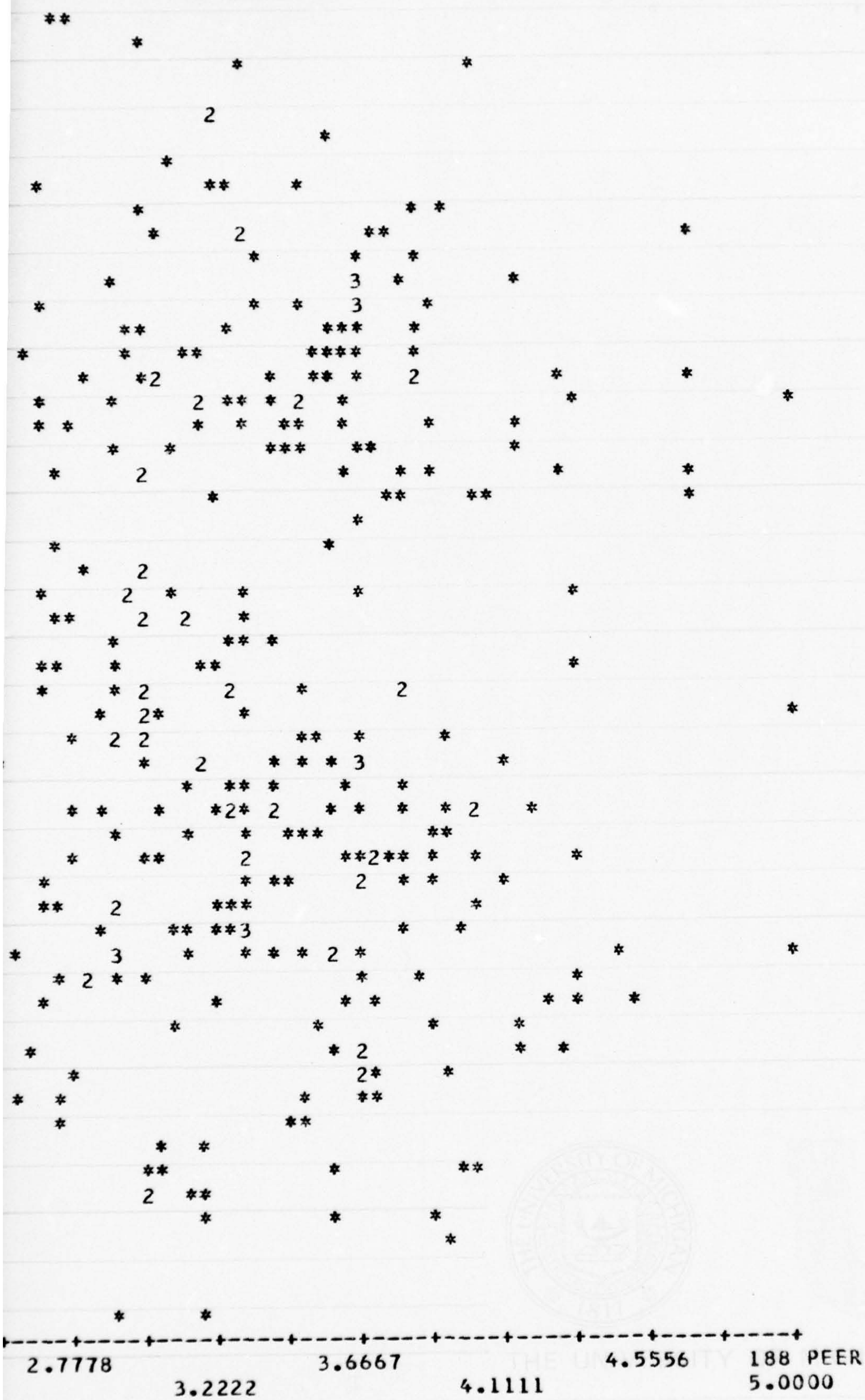

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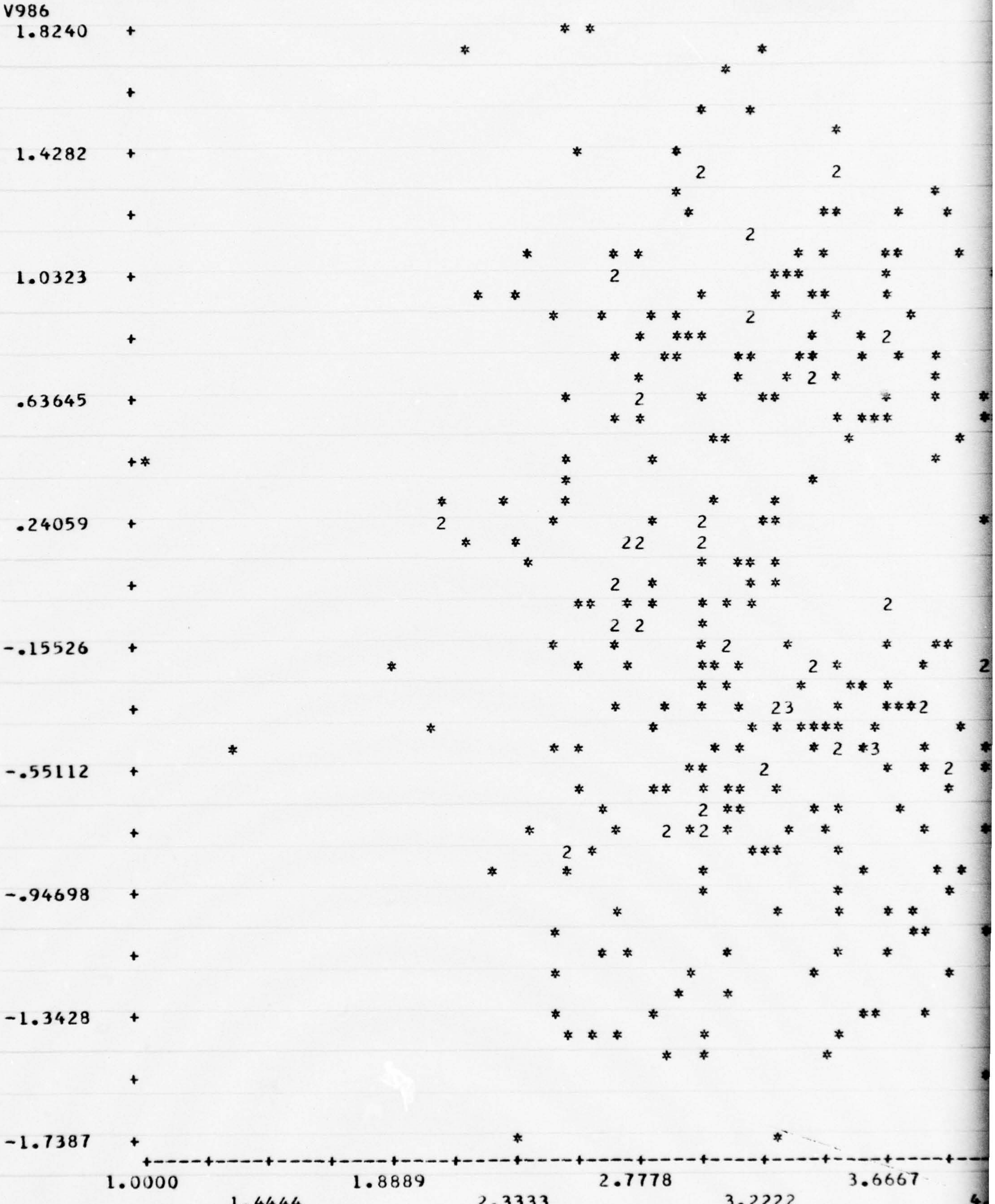

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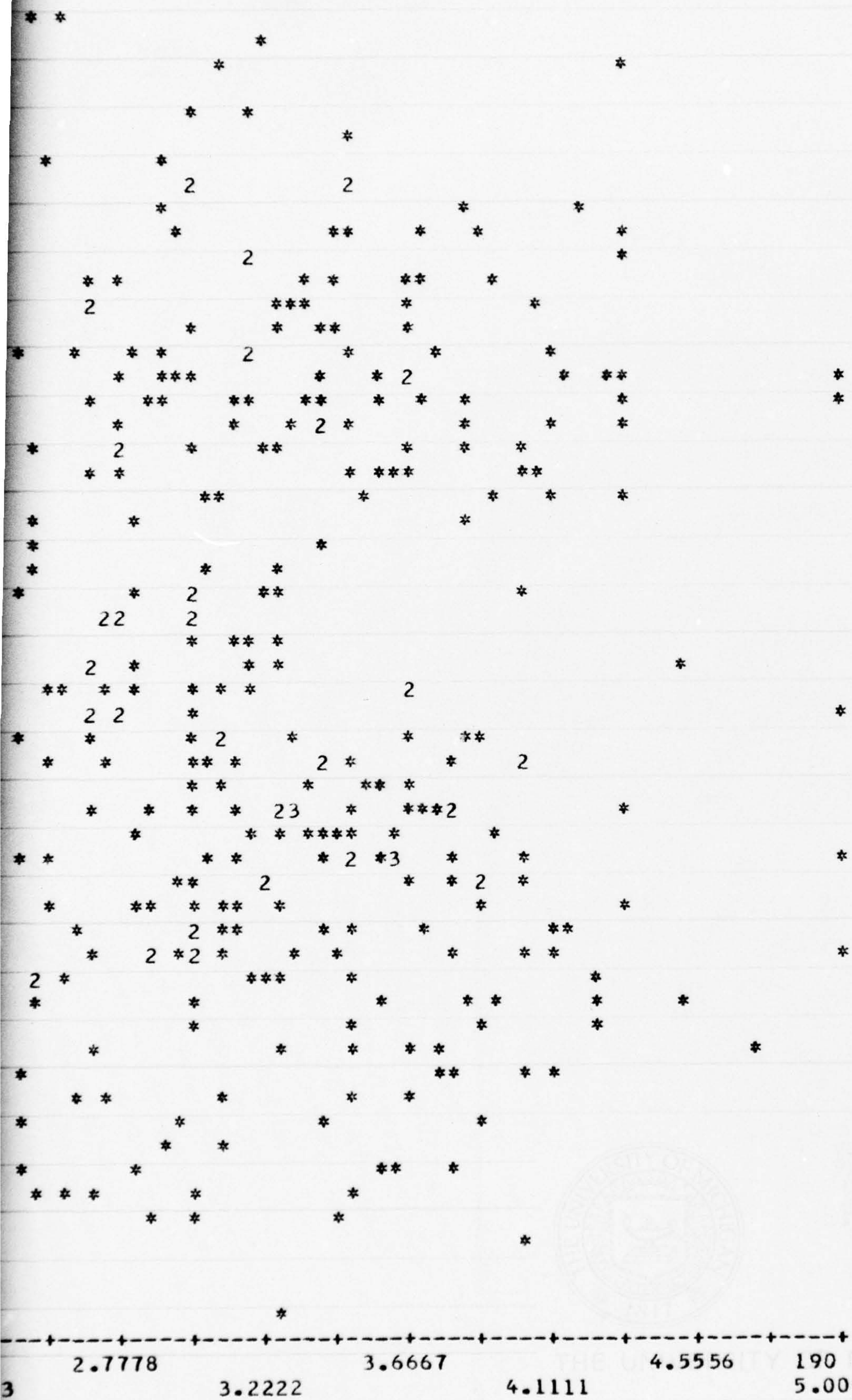

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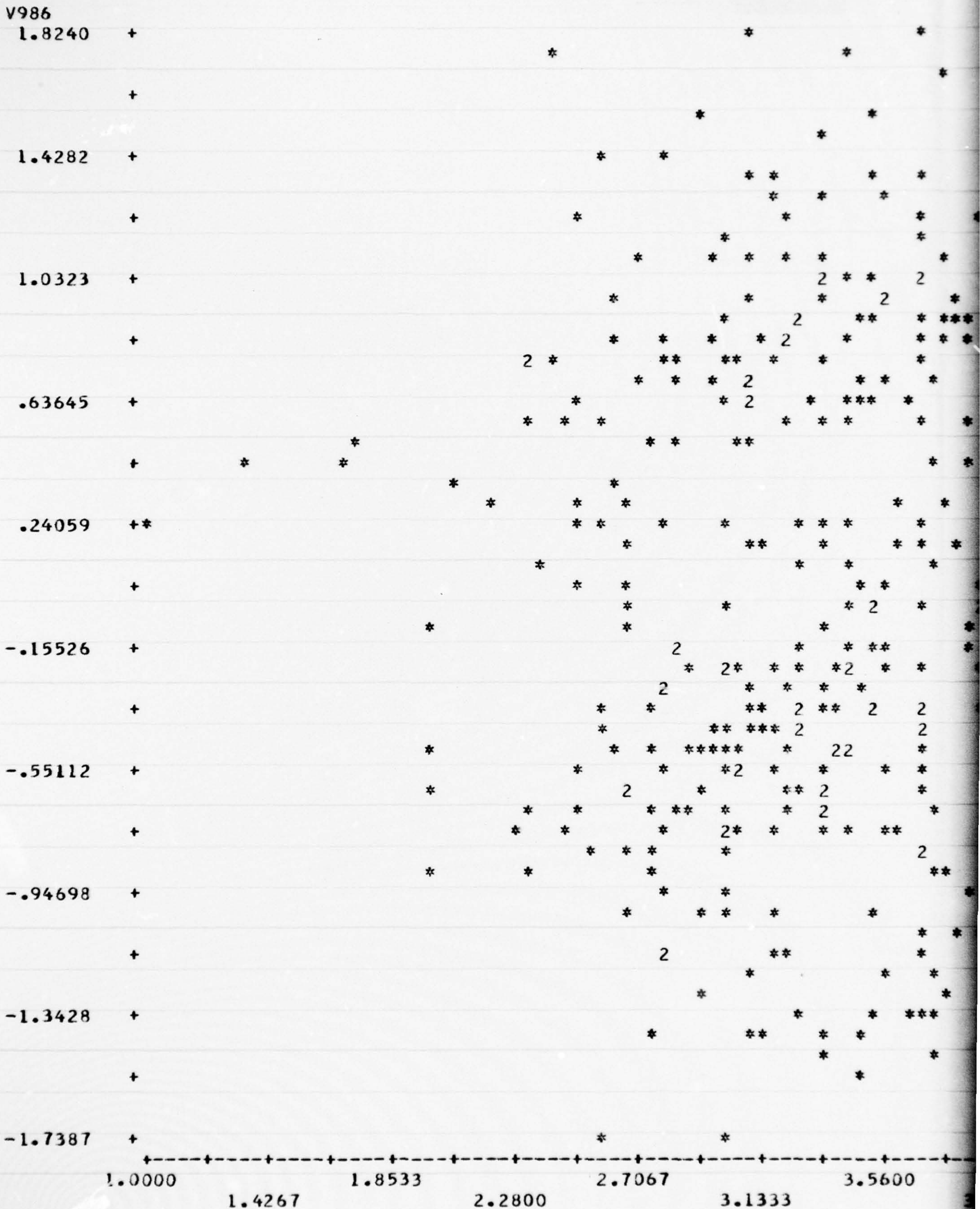

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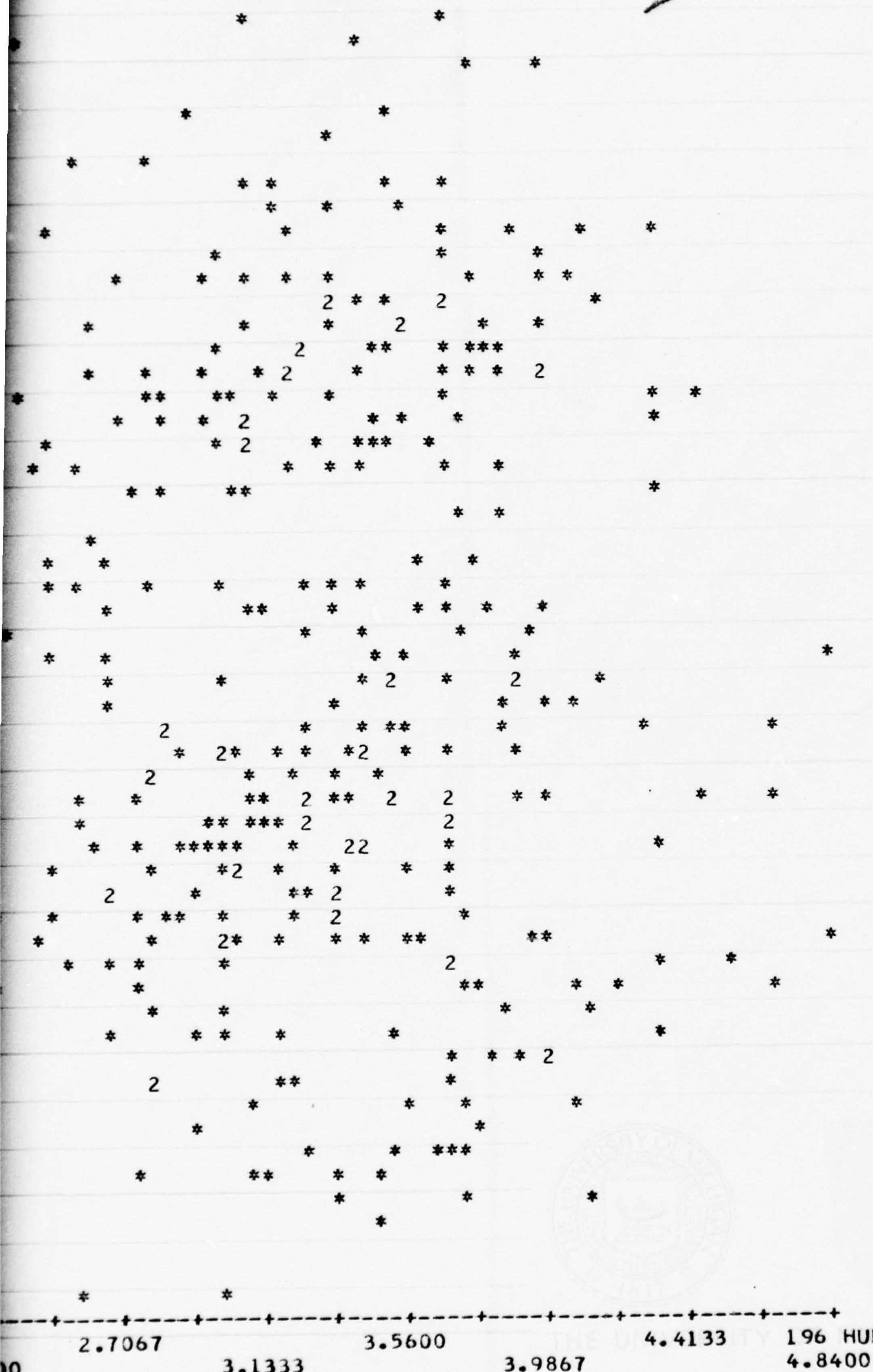

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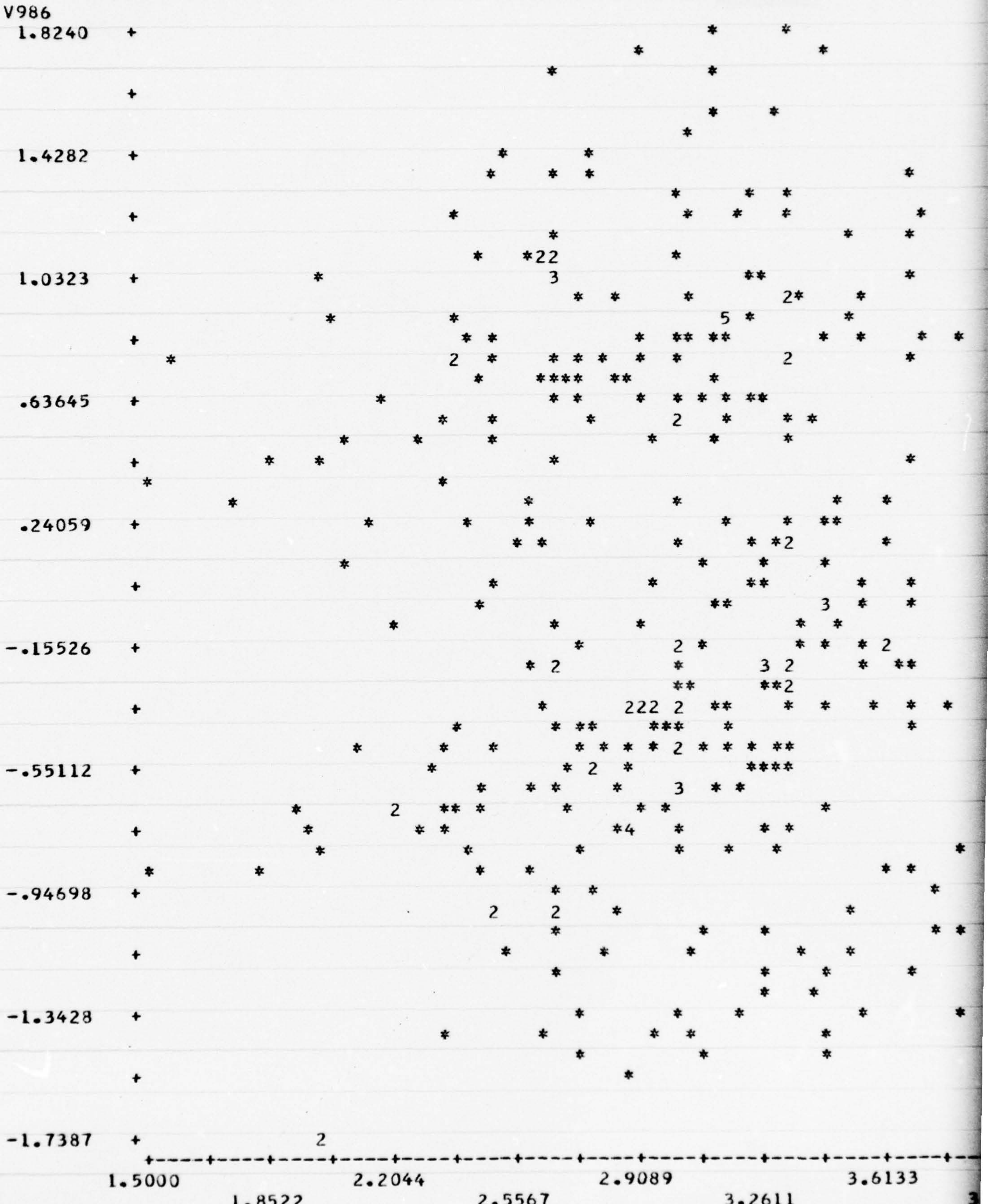

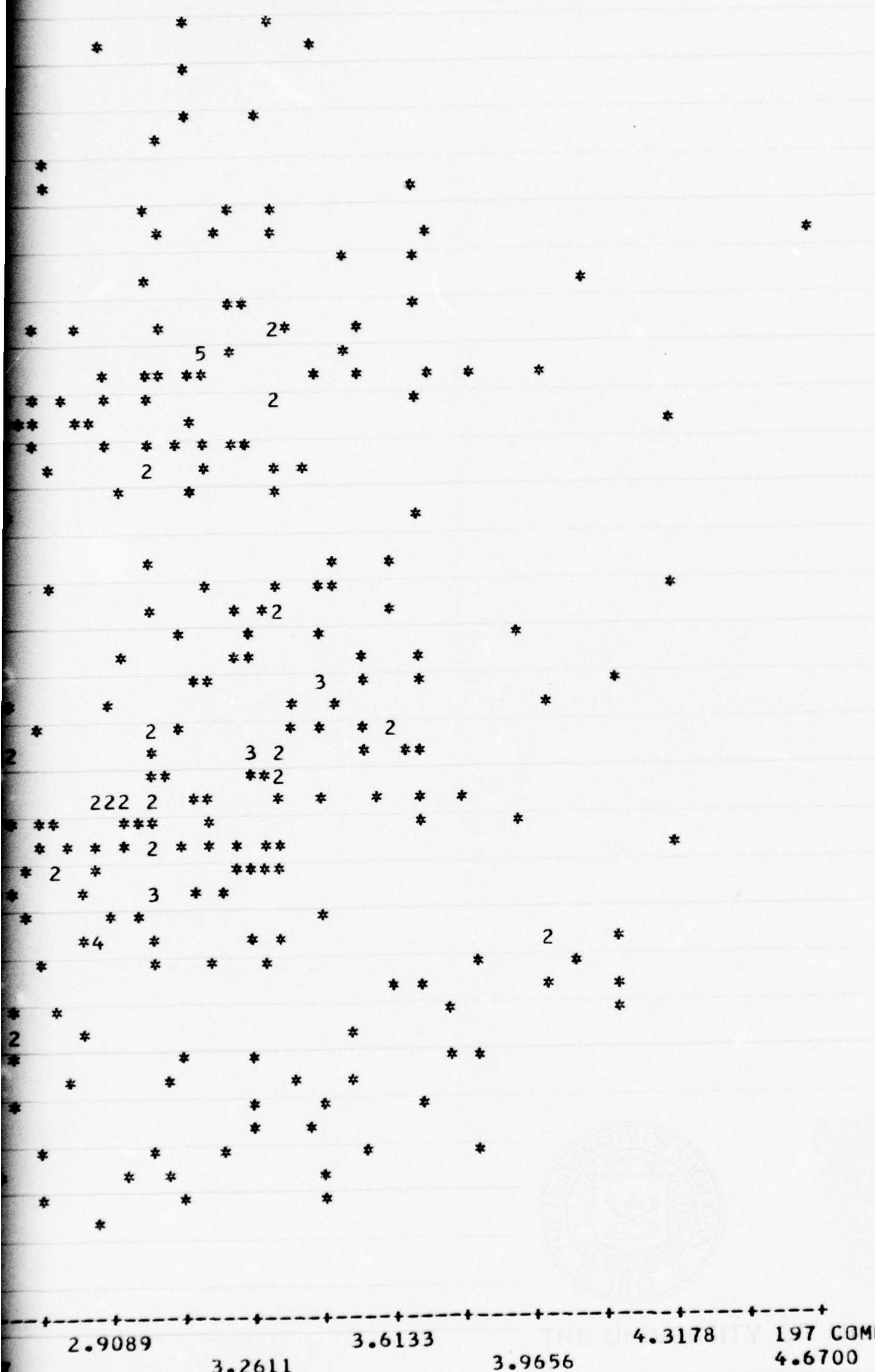
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3.2611
3.6133
3.9656
4.3178
4.6700
197 COMM

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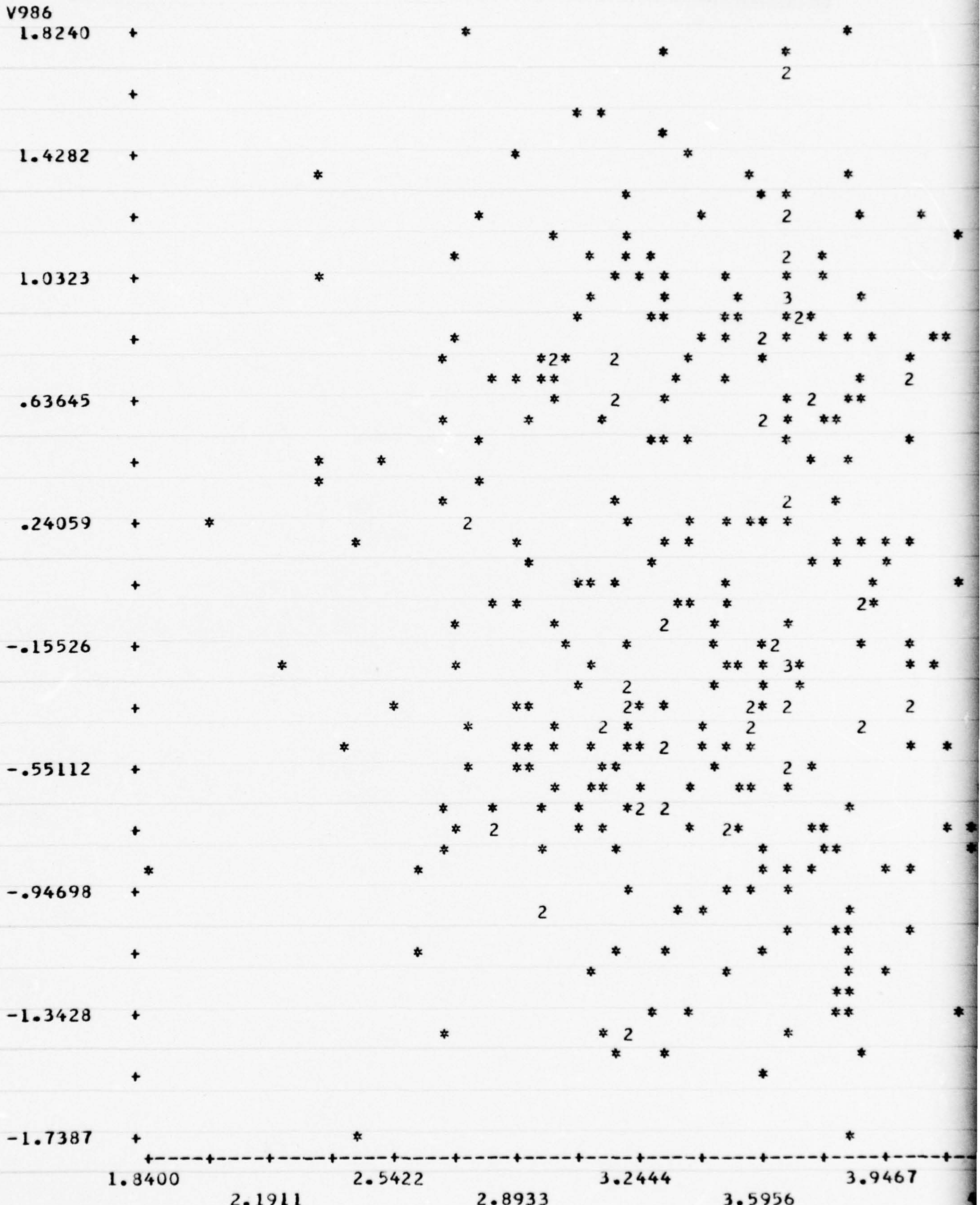

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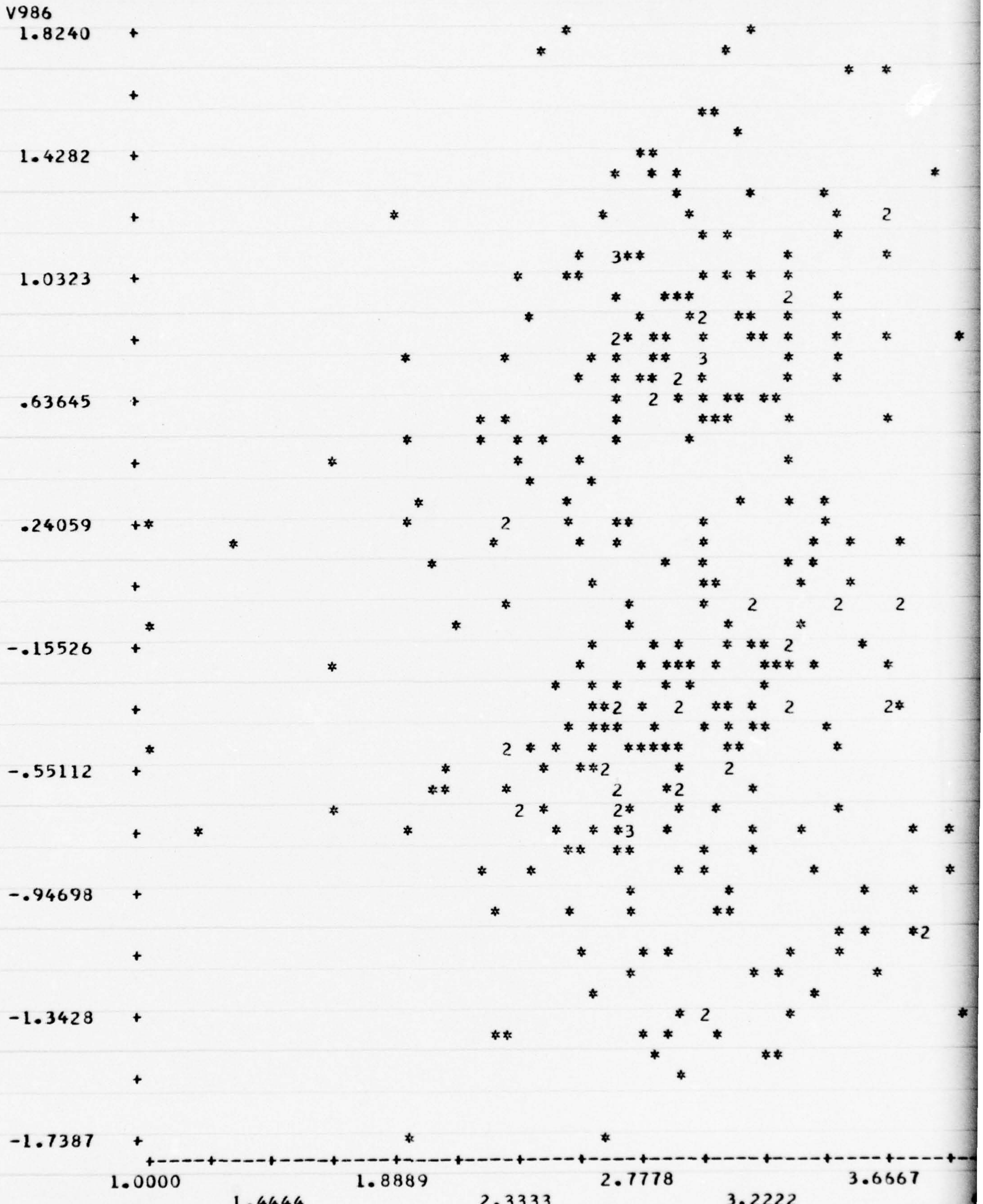

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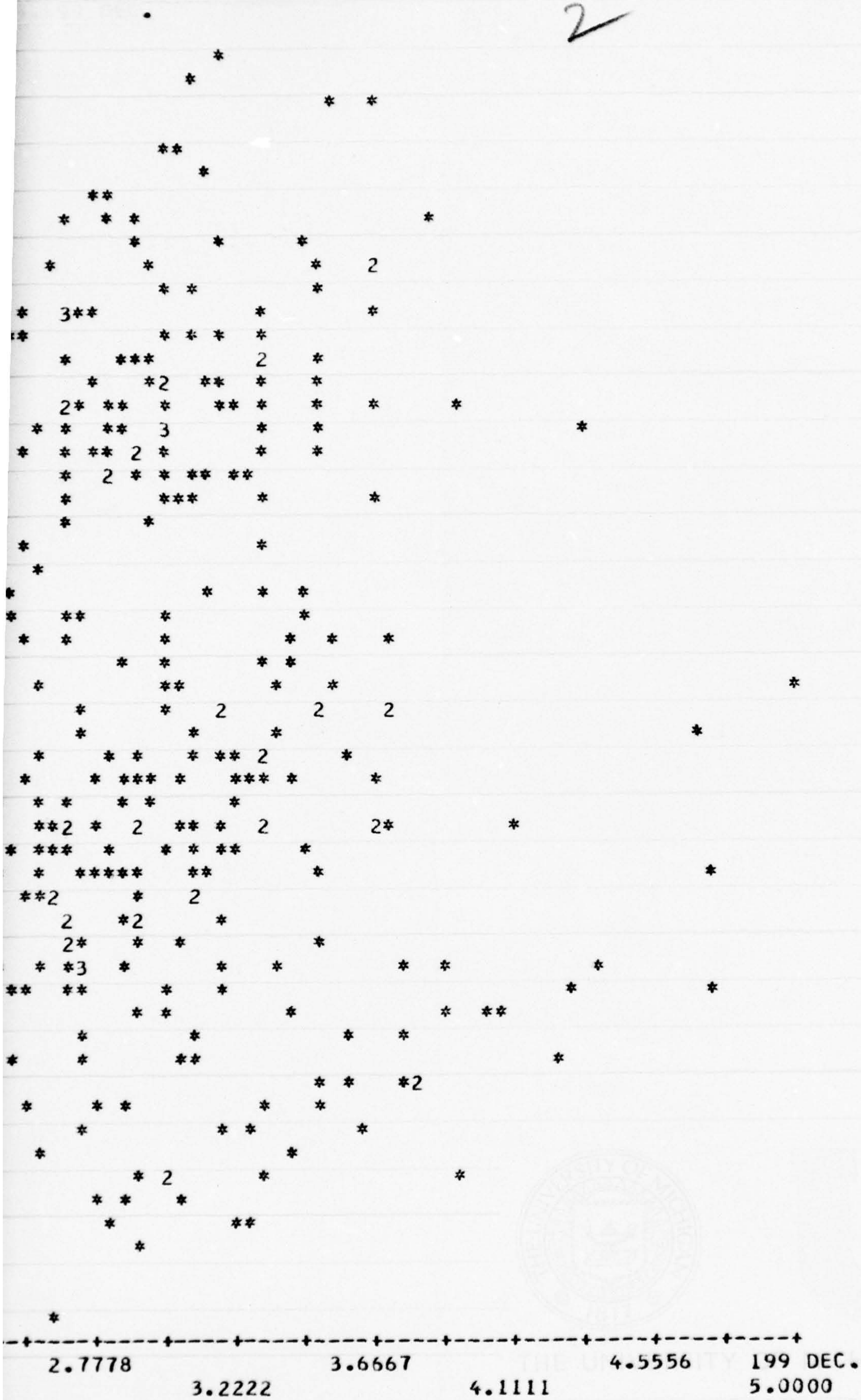

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B-210

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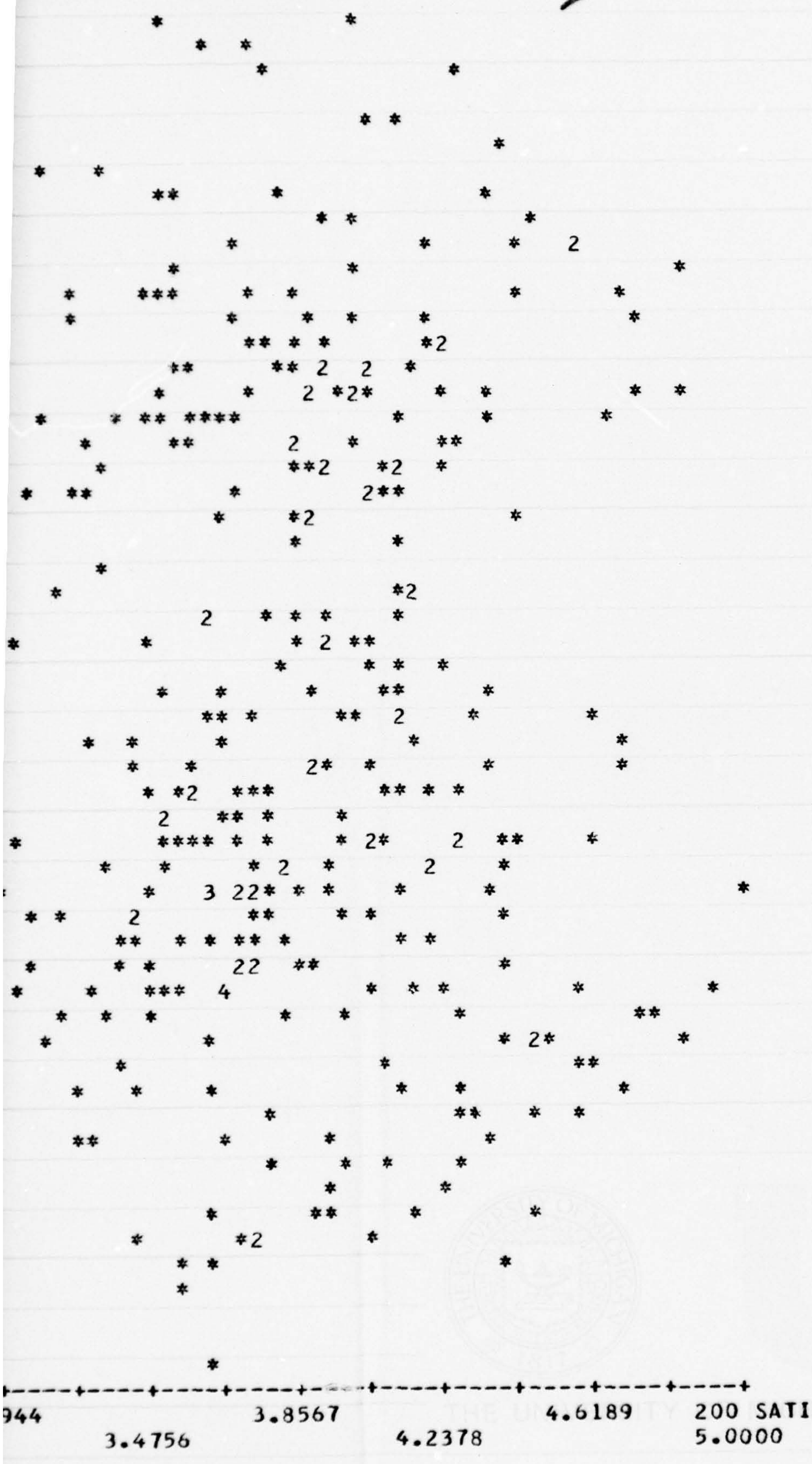

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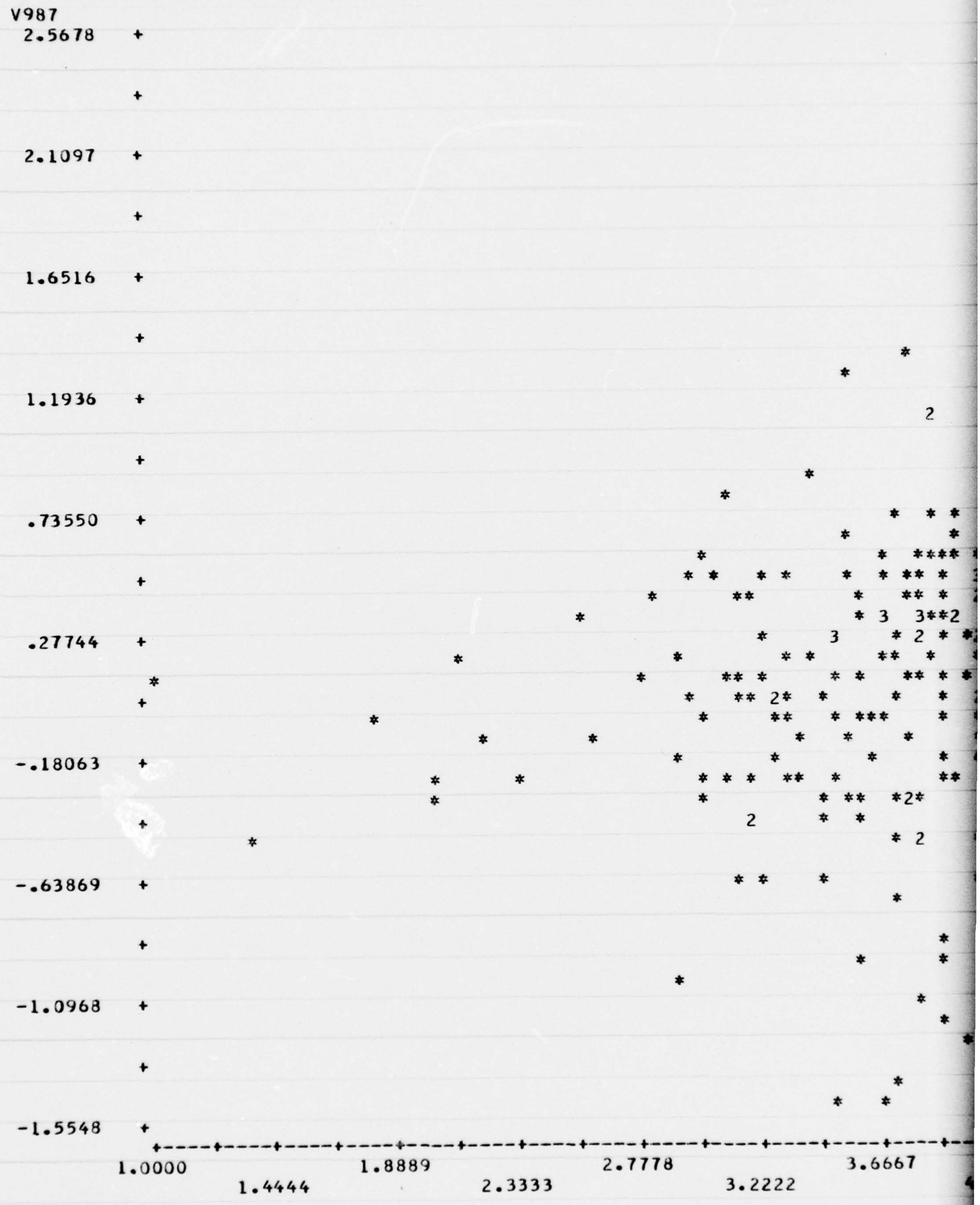

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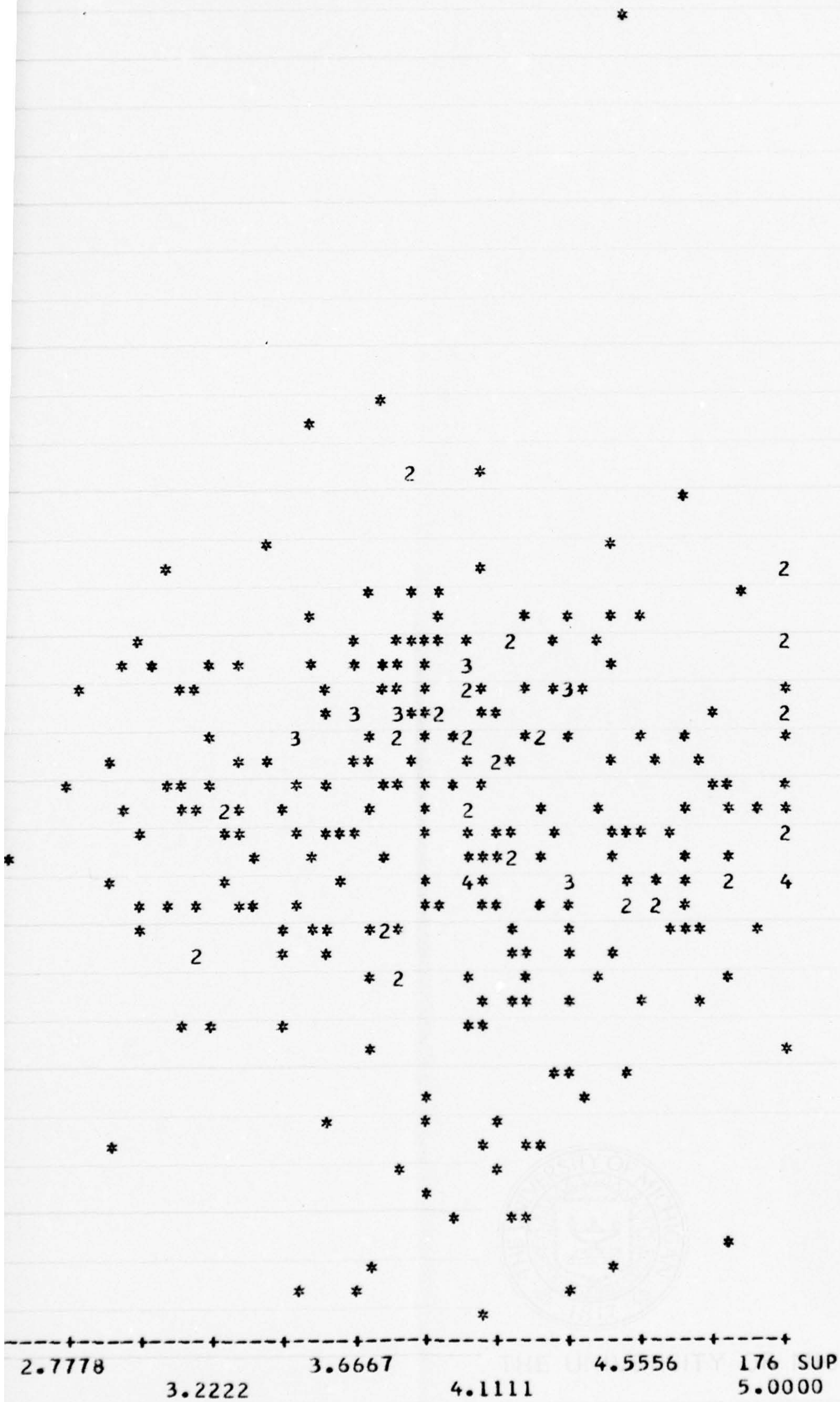

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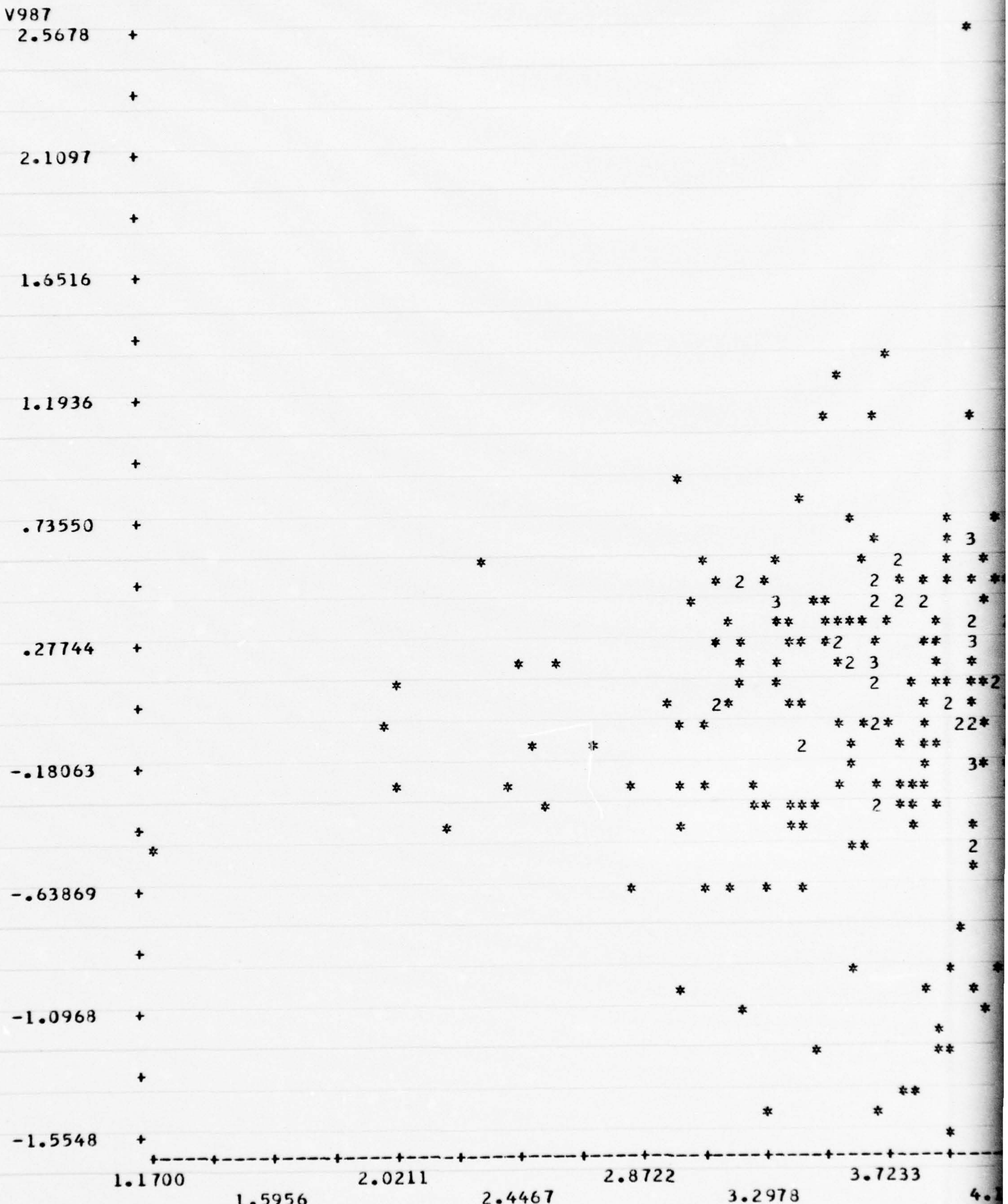

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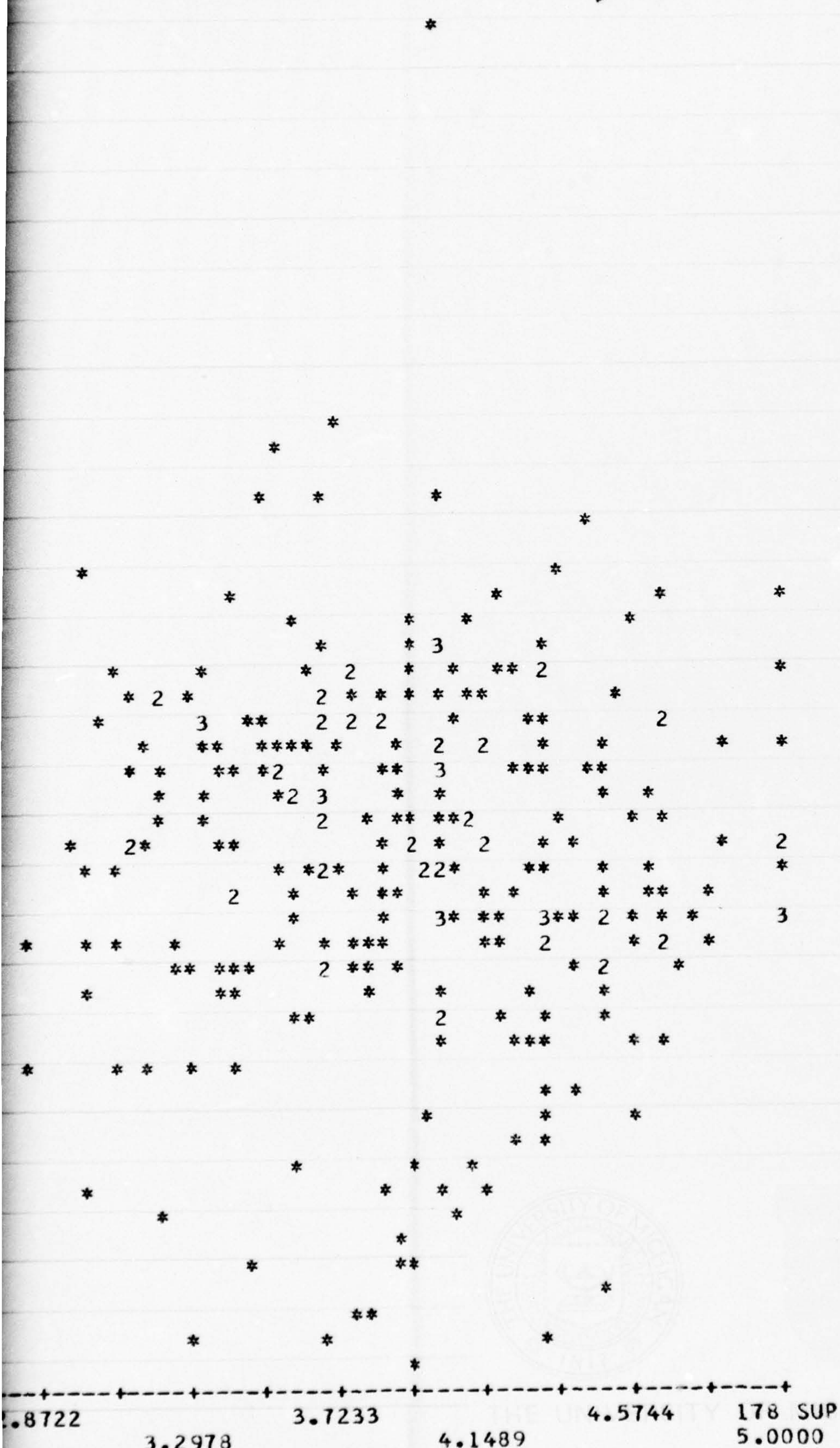

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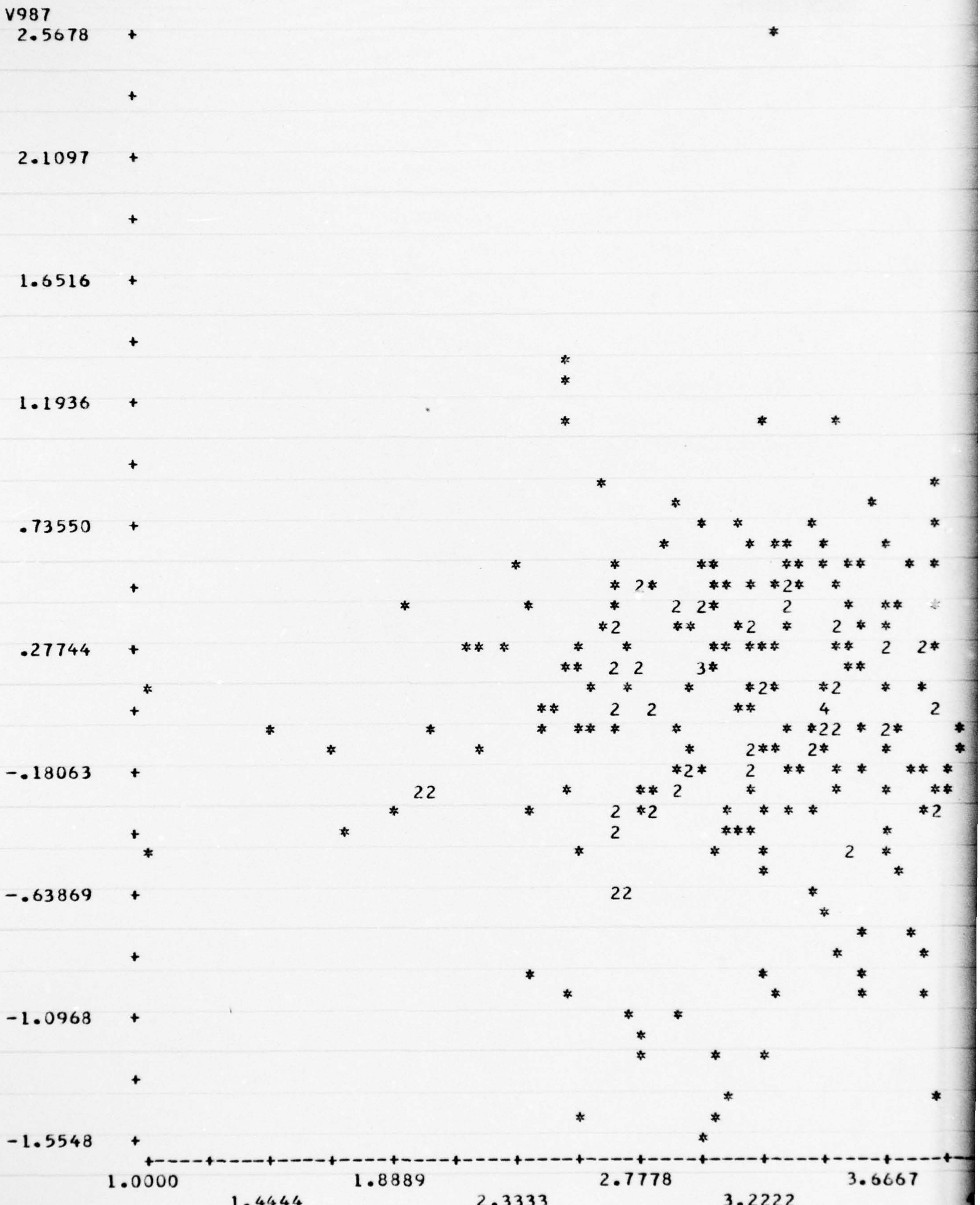

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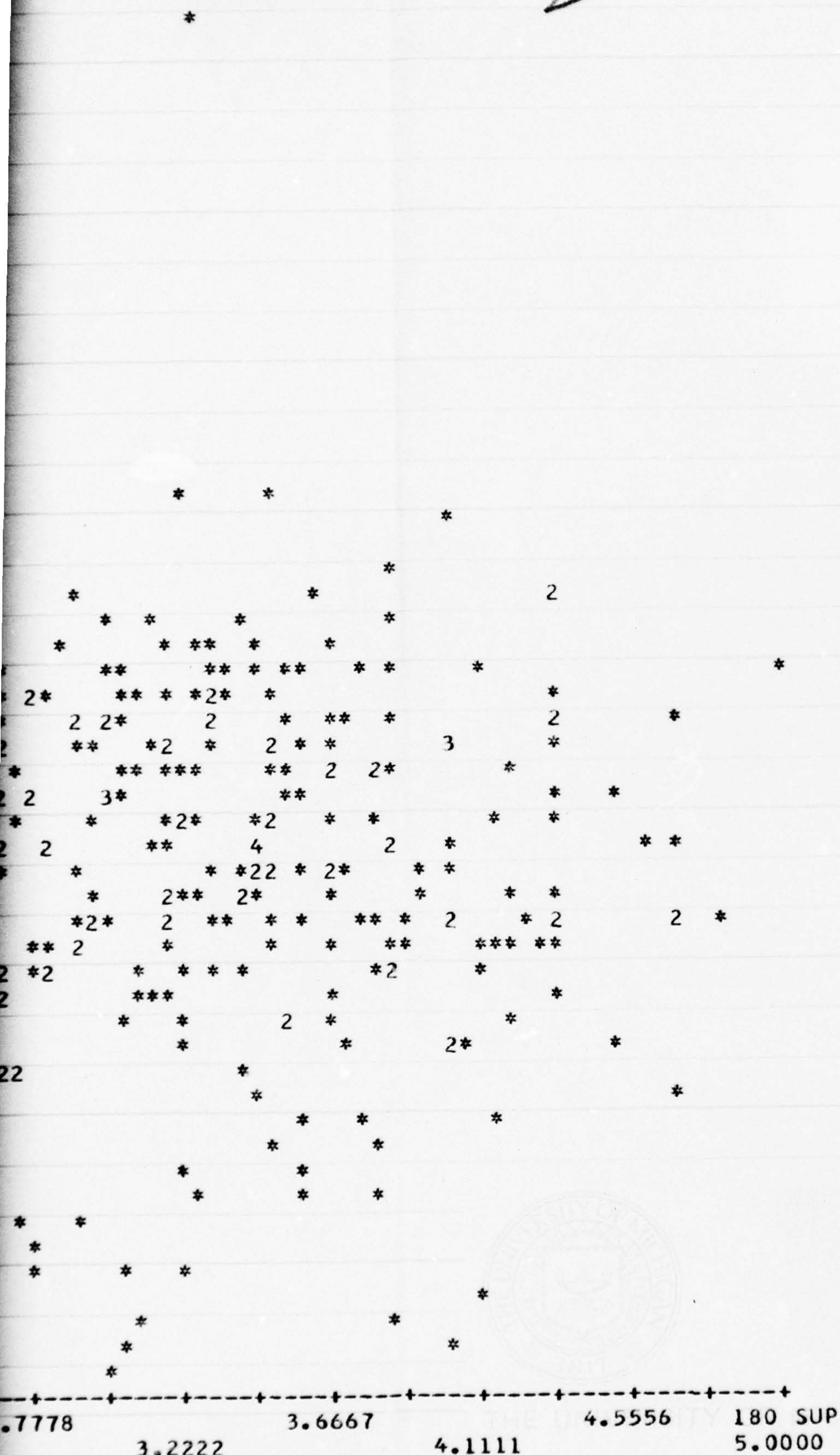

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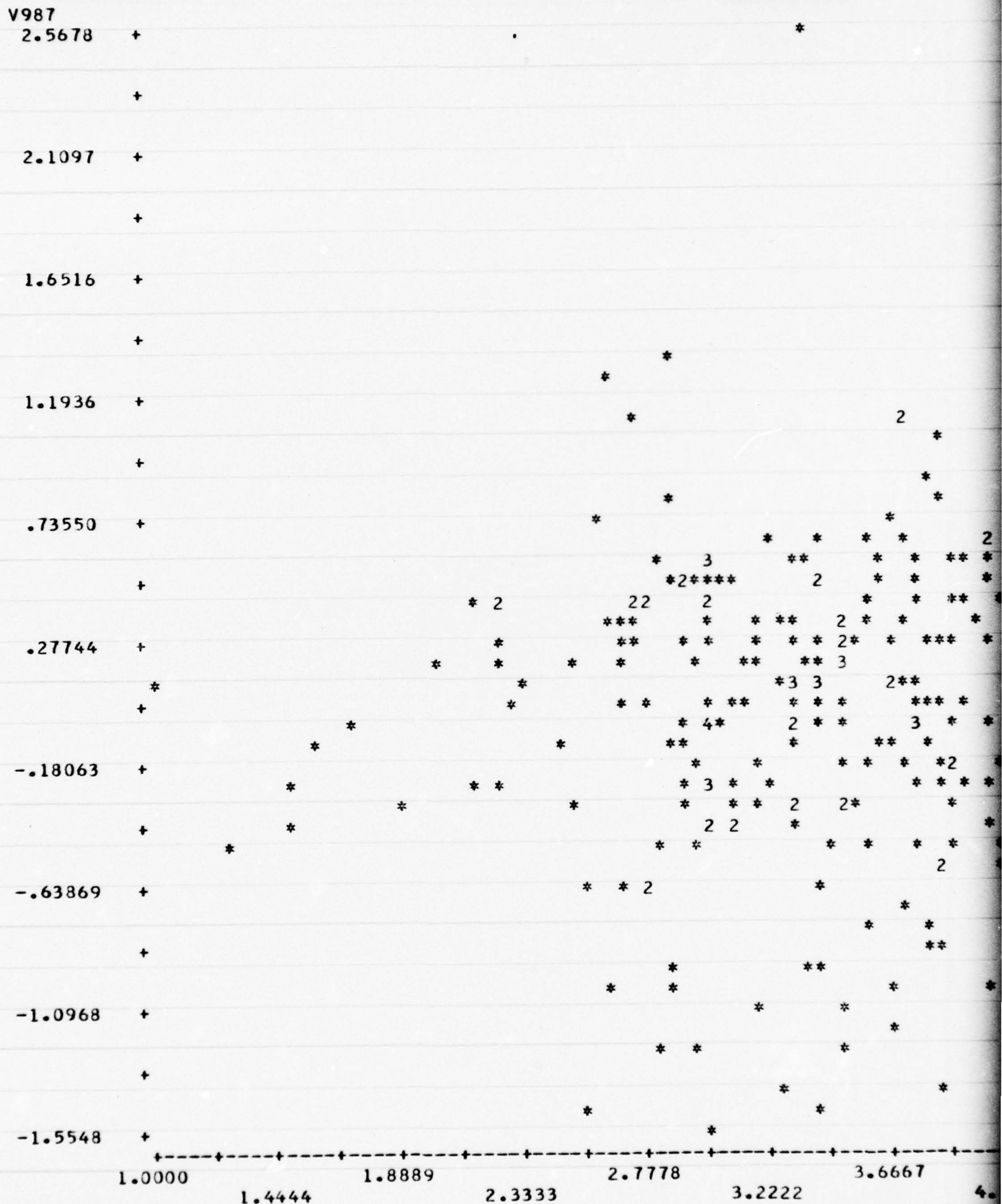

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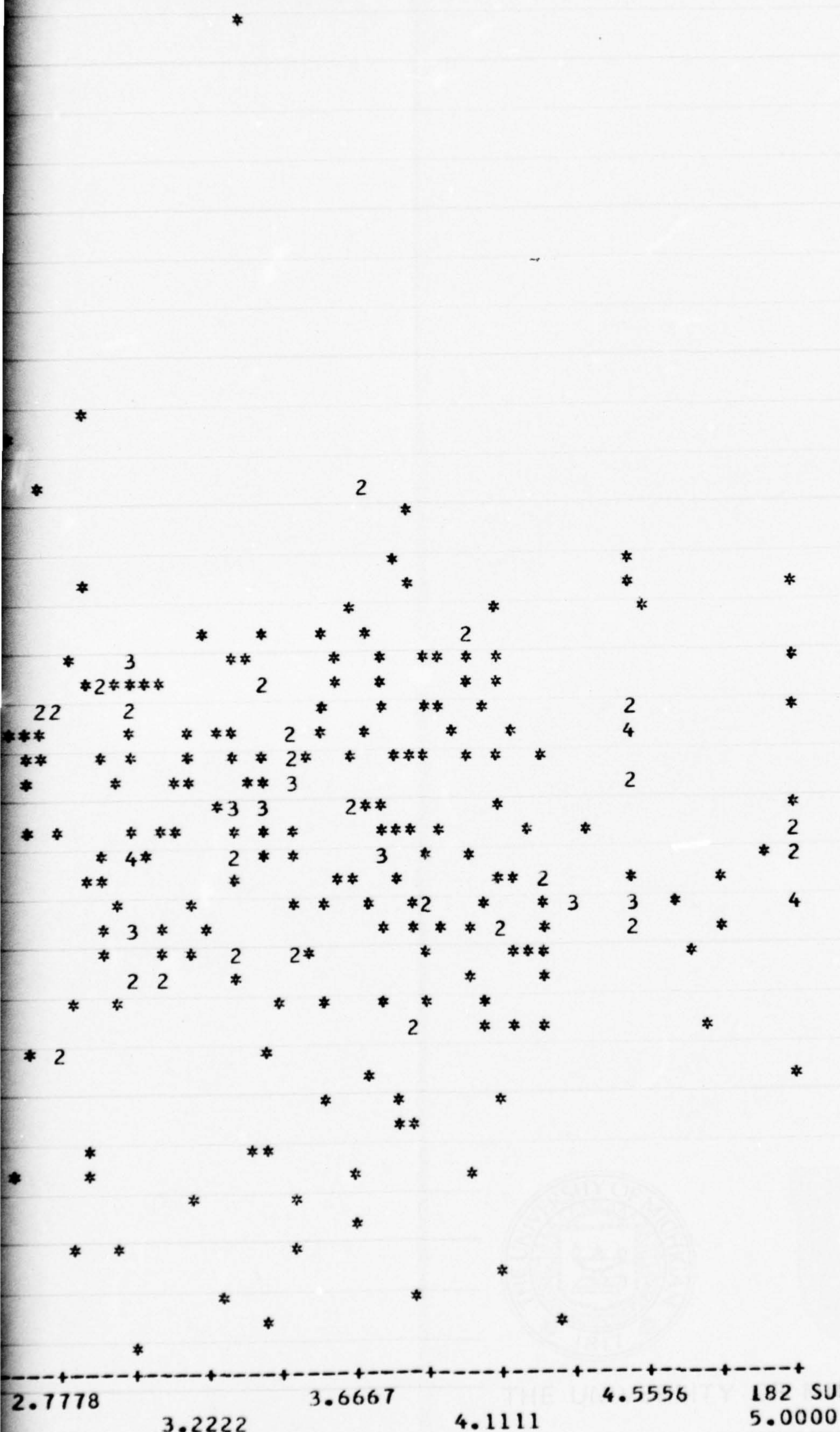

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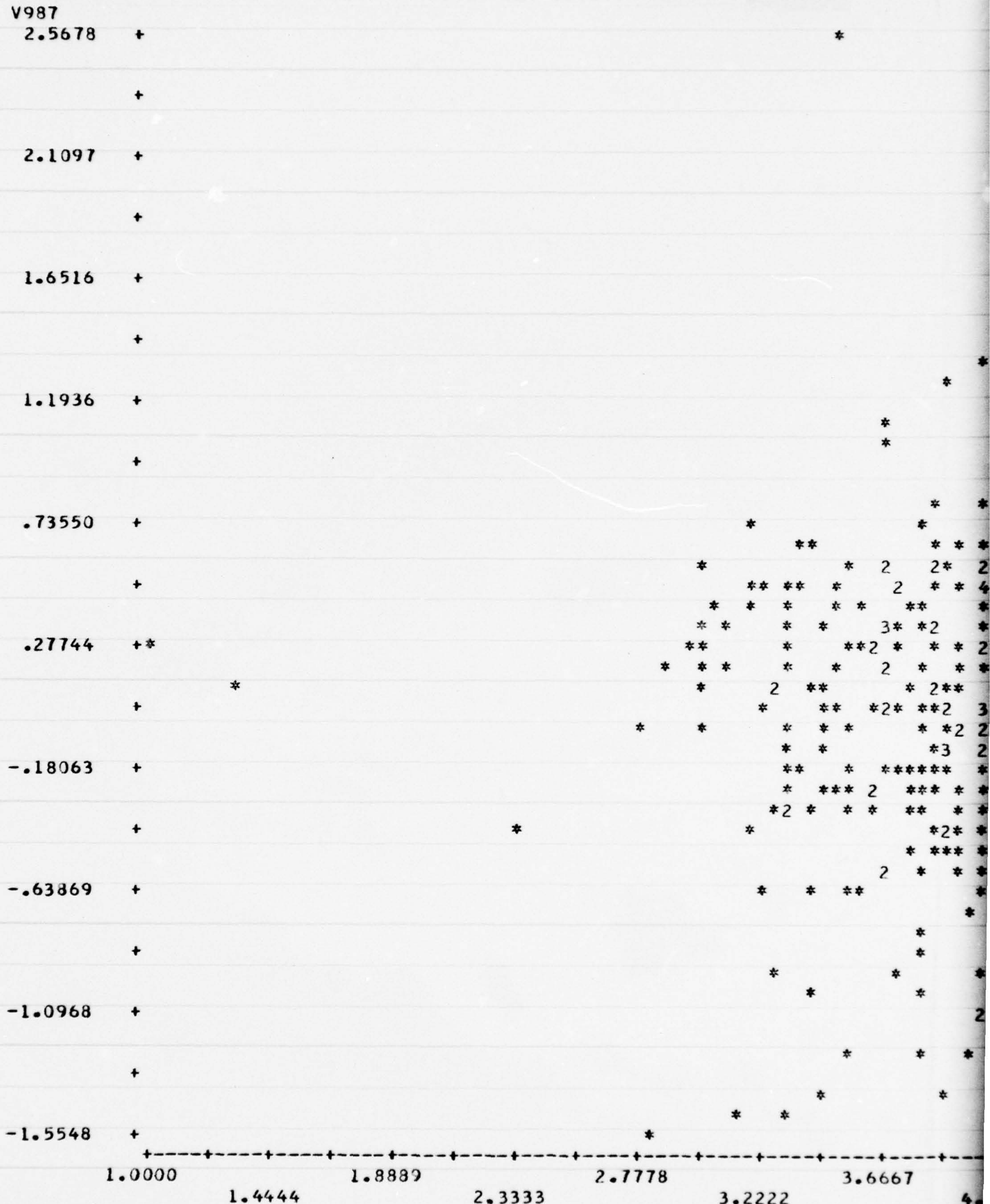

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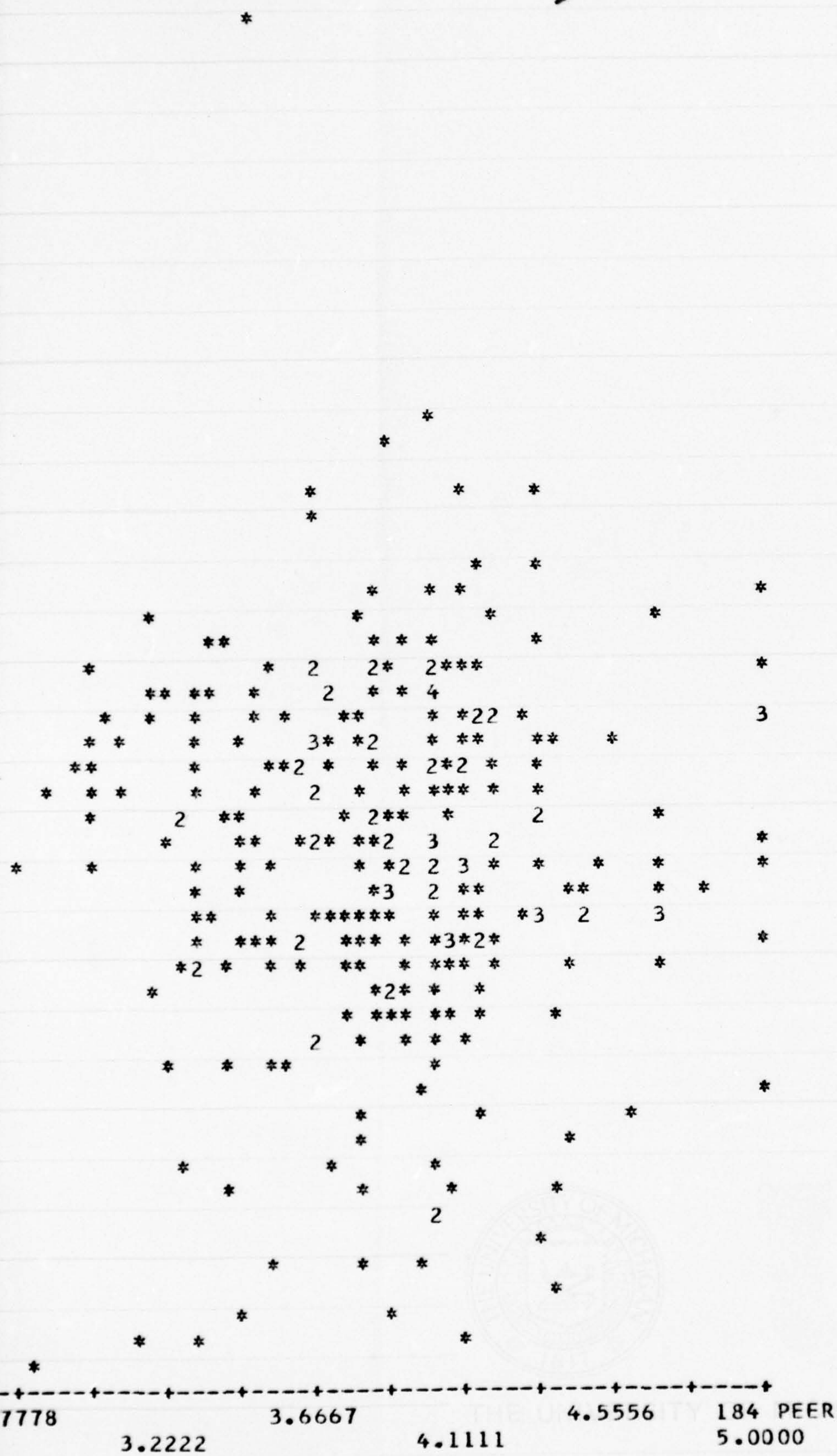

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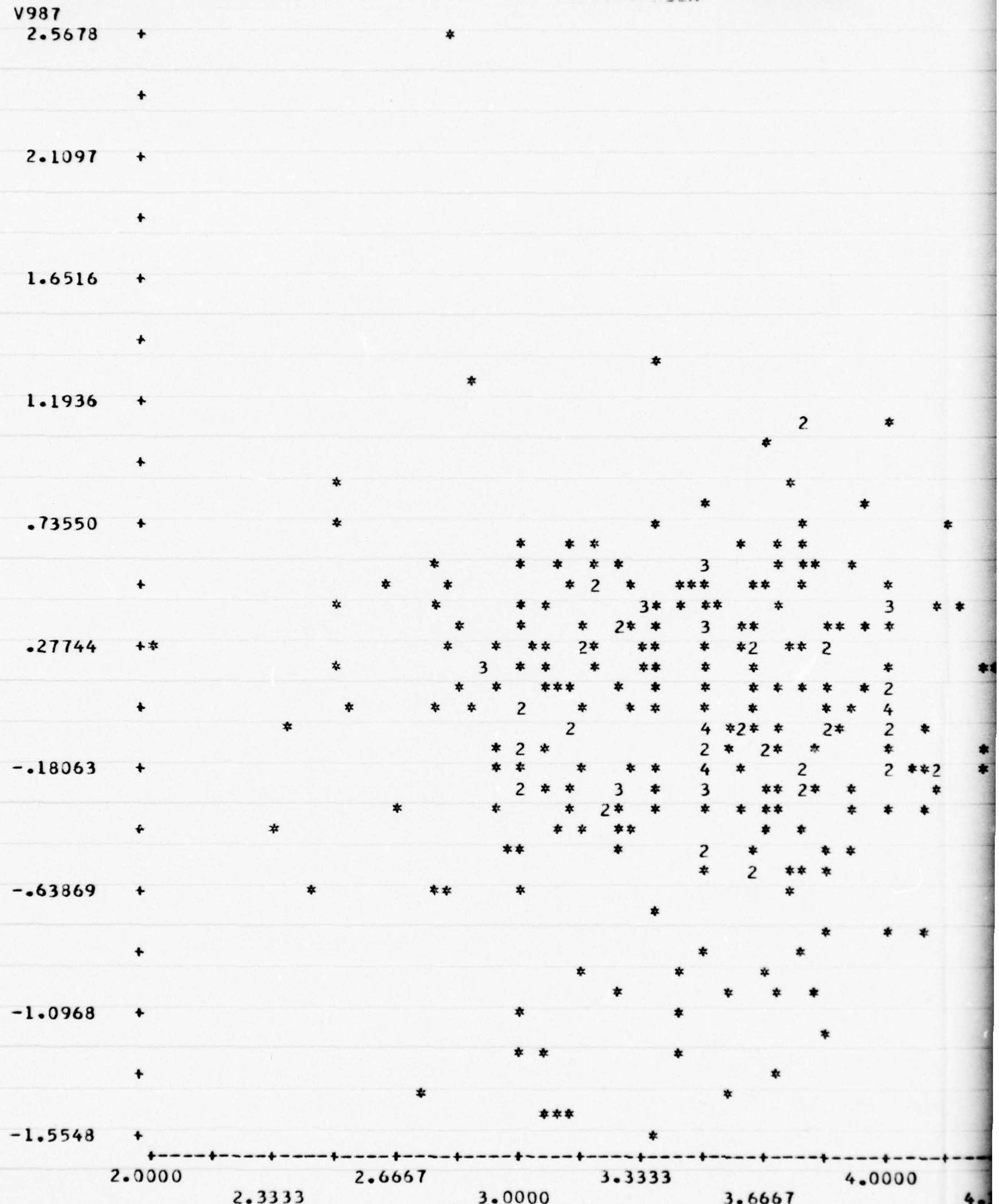

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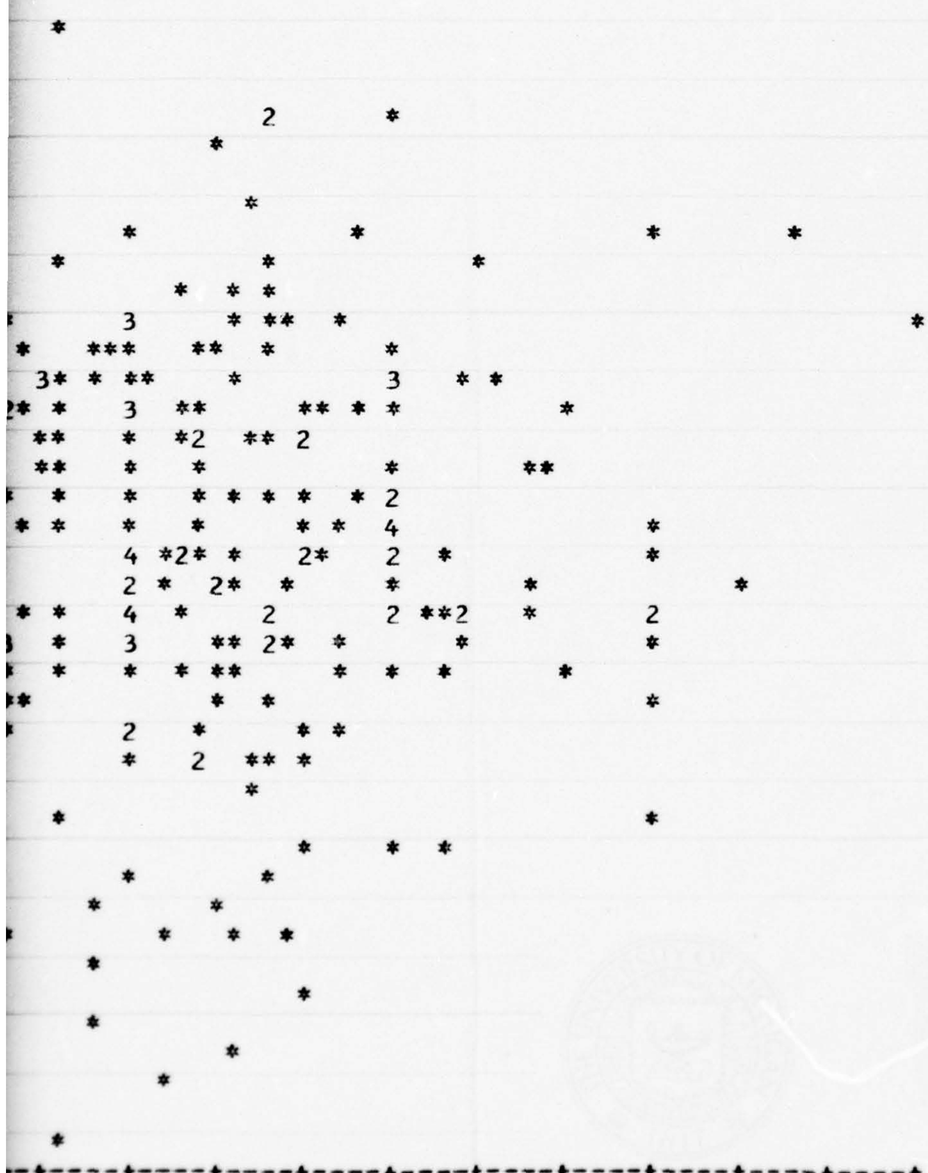

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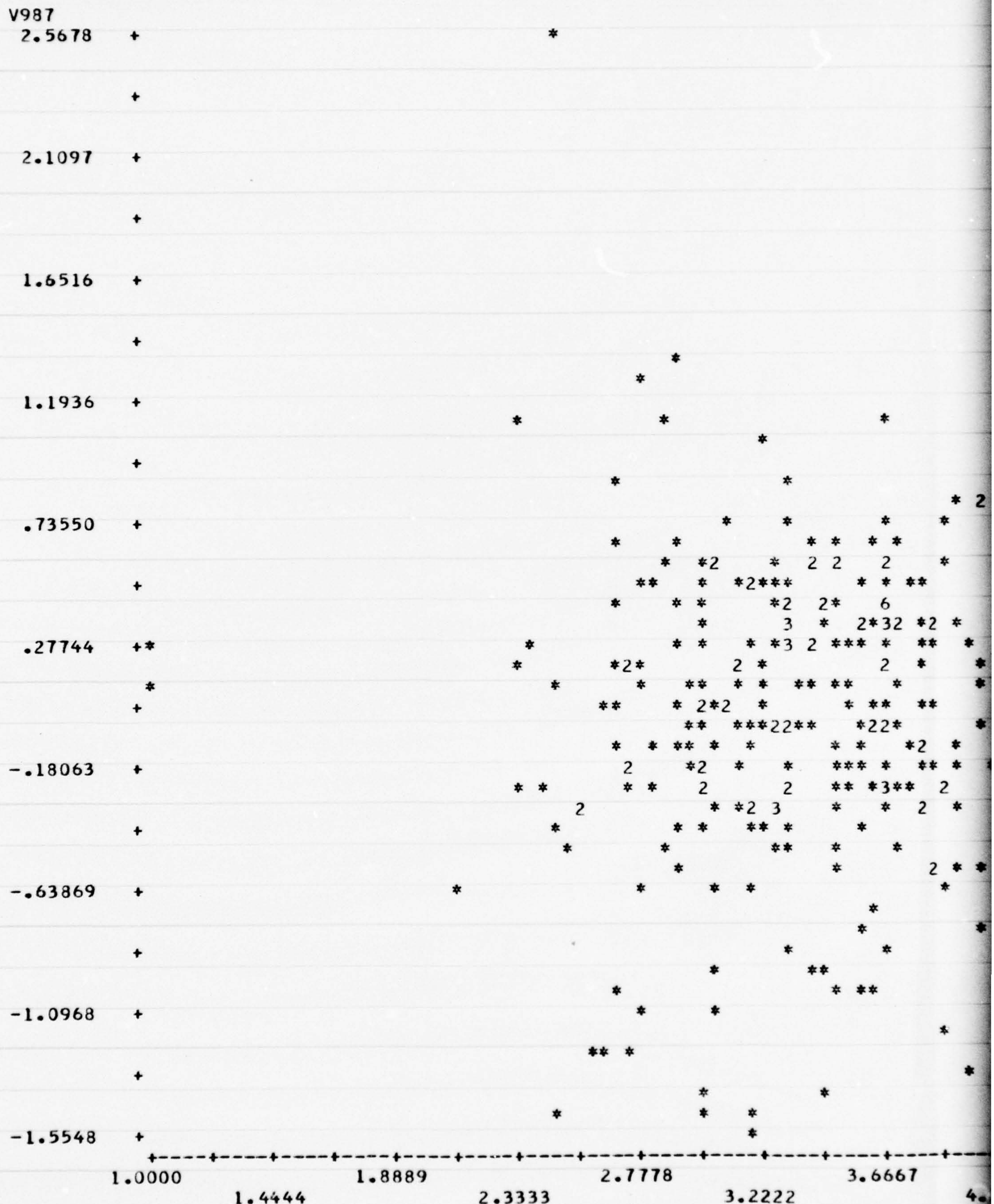

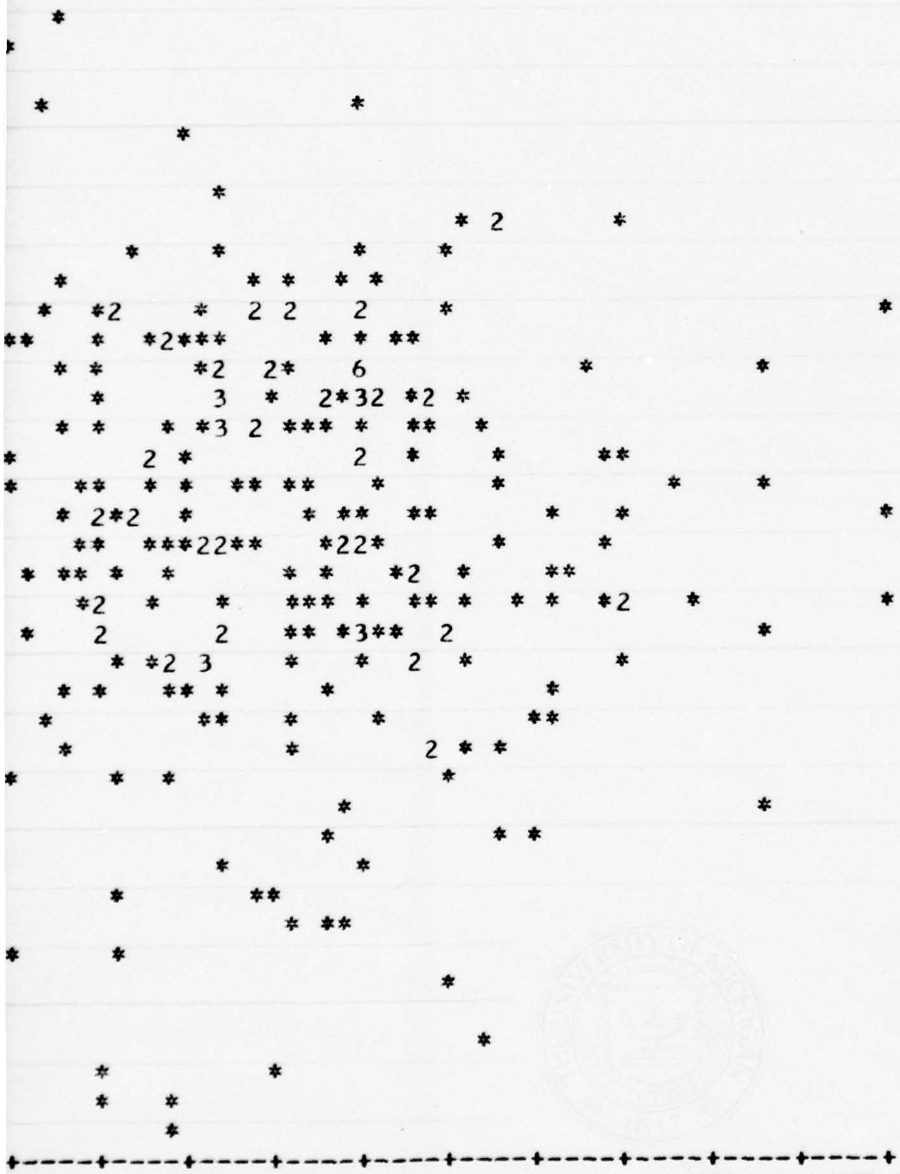
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4.1111
4.5556
188 PEER
5.0000

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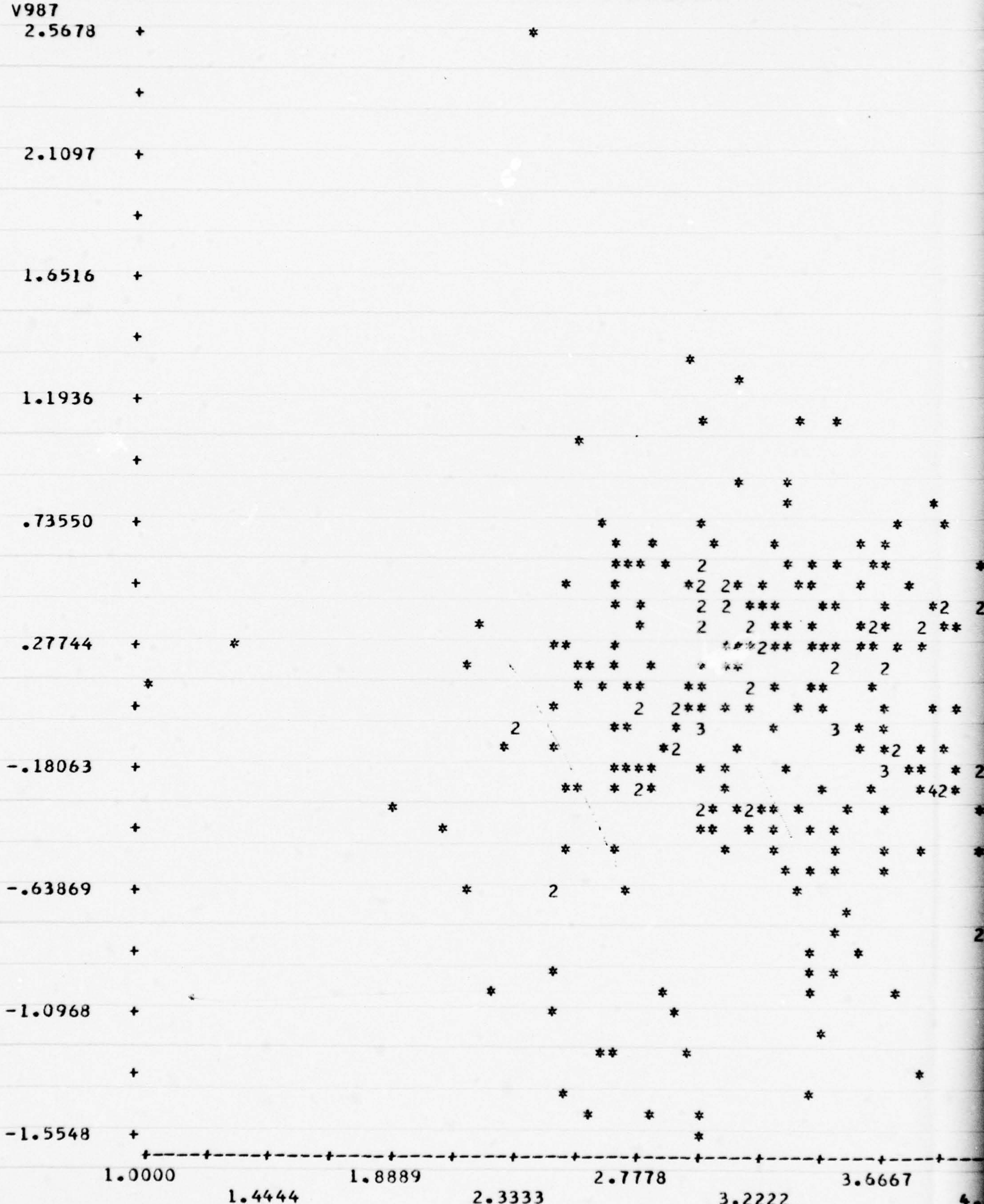

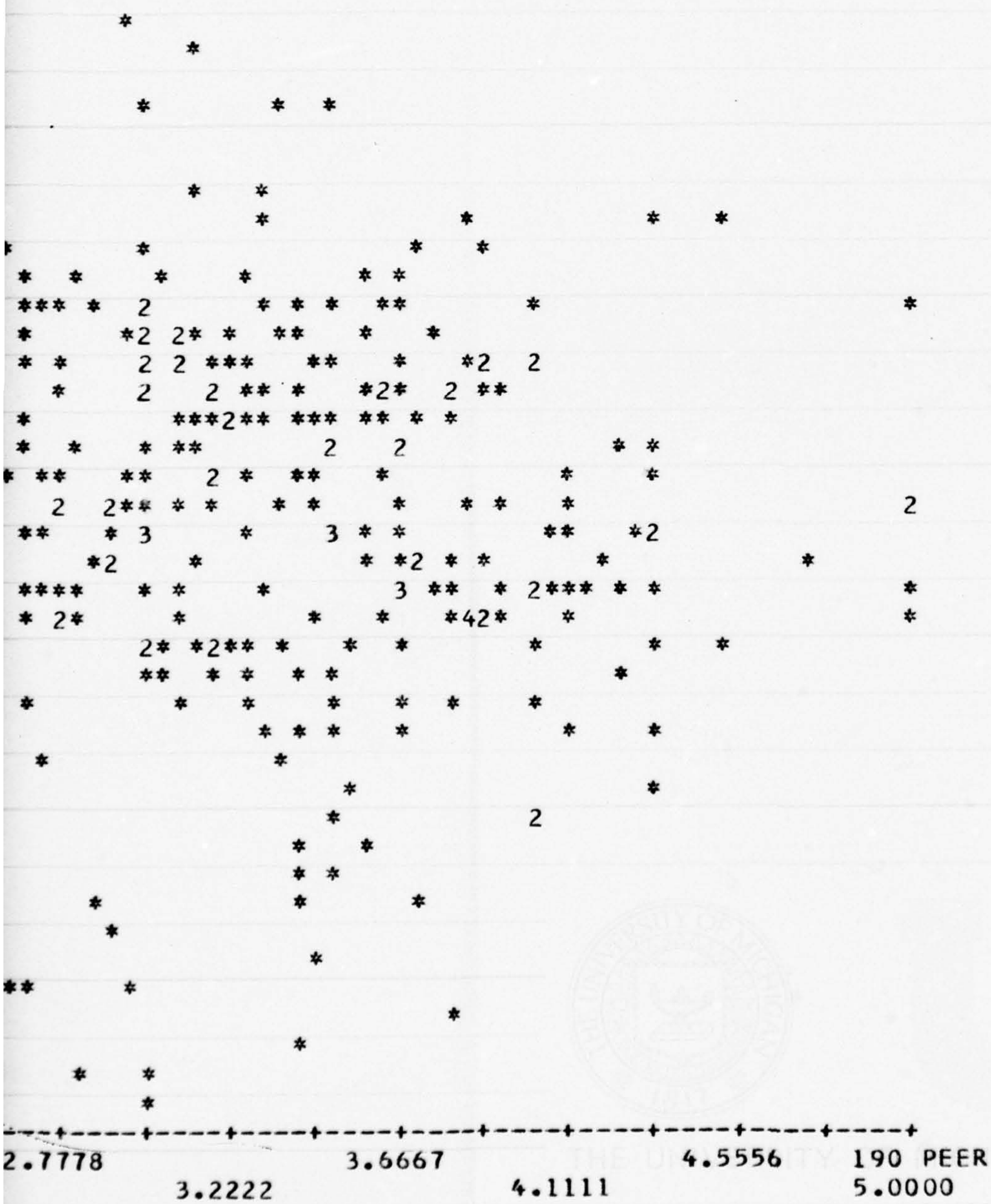
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4.1111
4.5556
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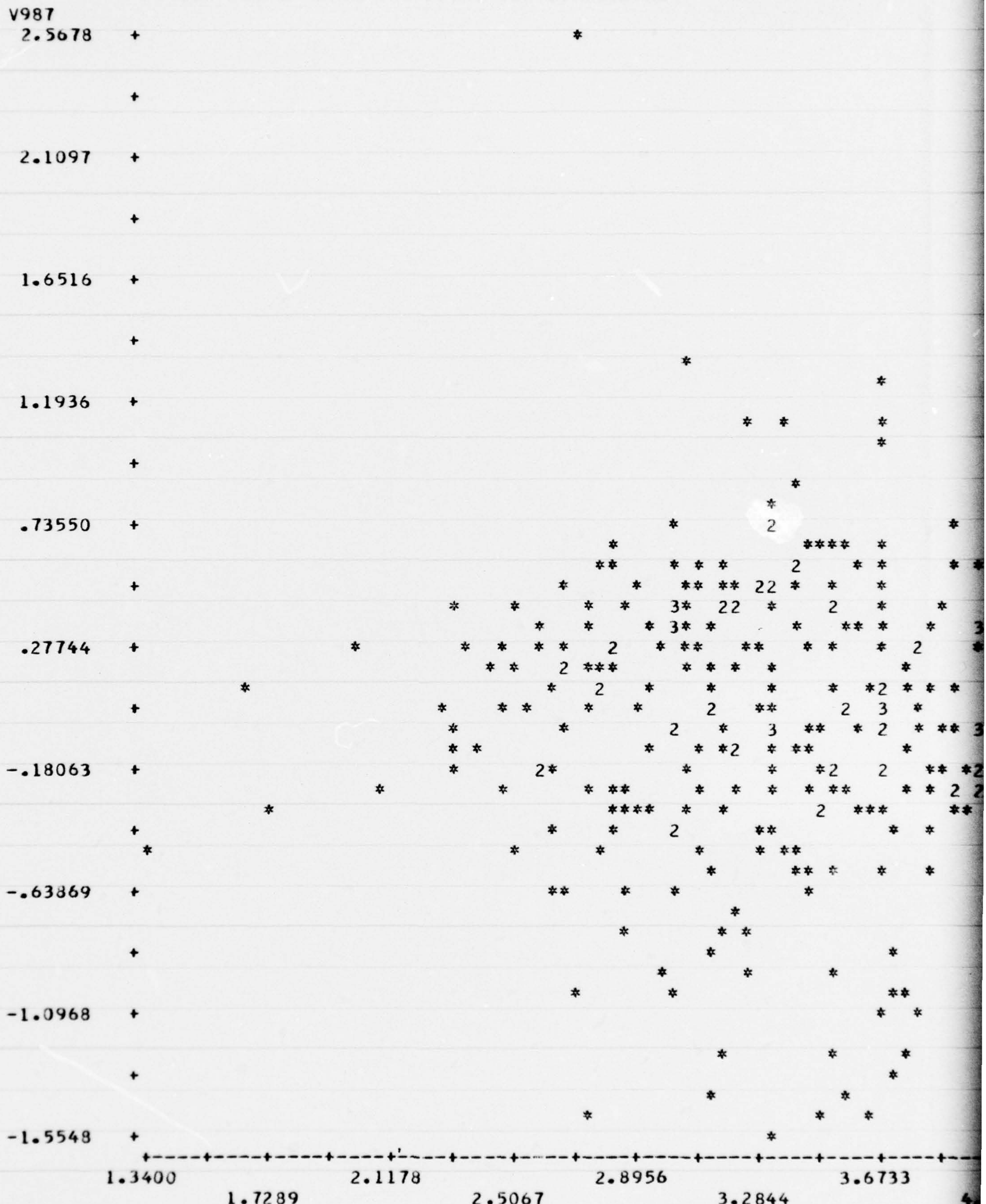

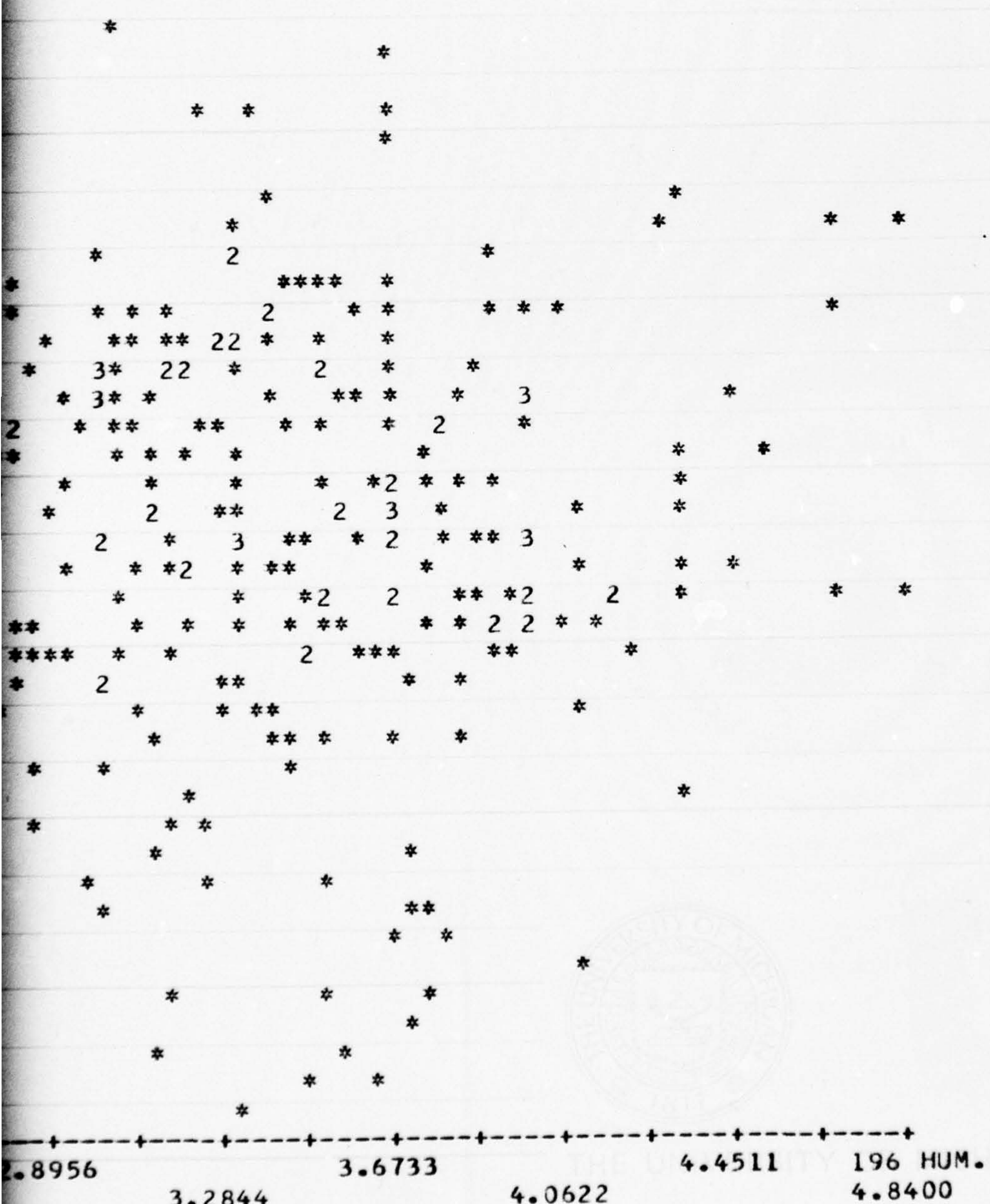

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4.4511
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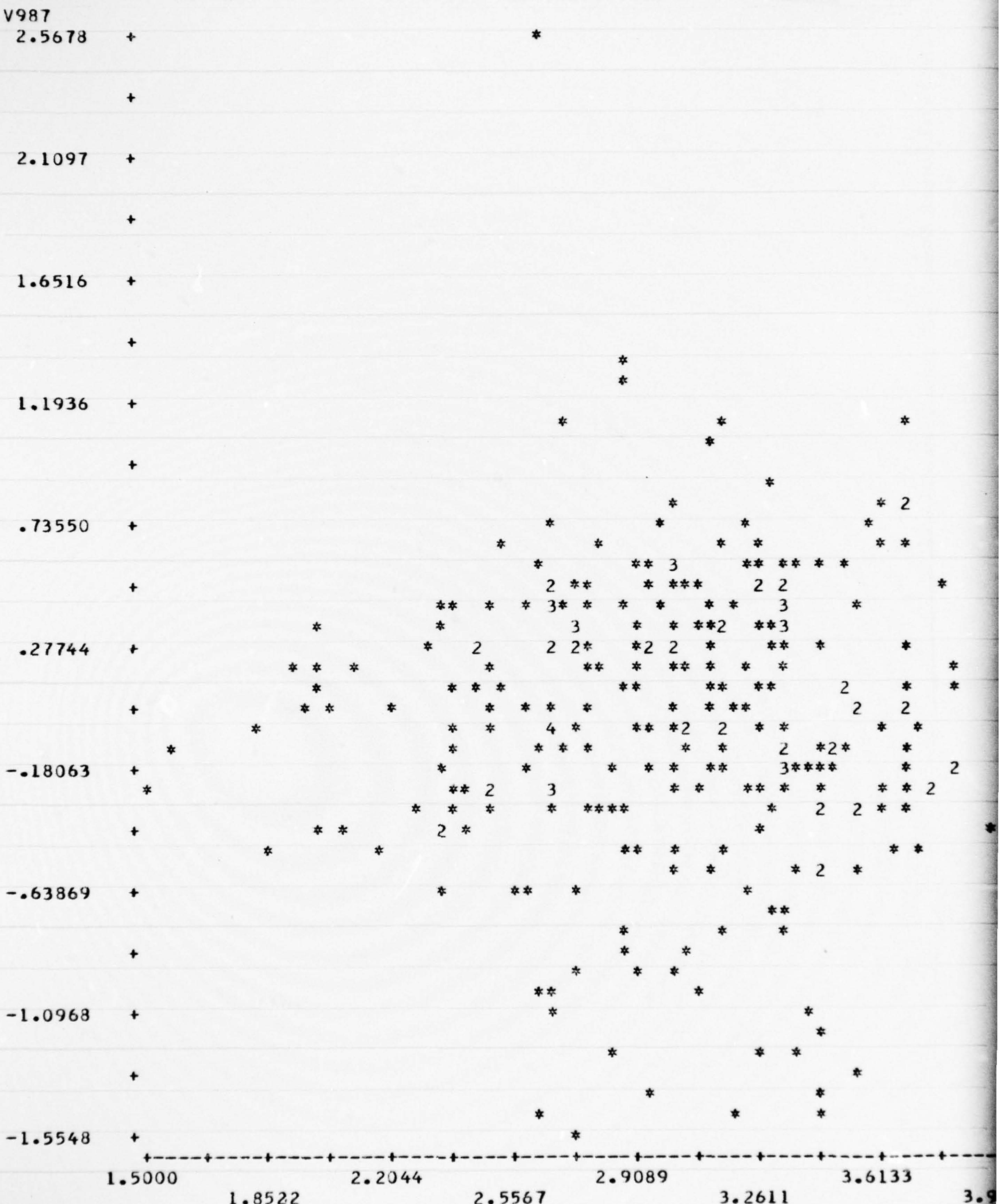

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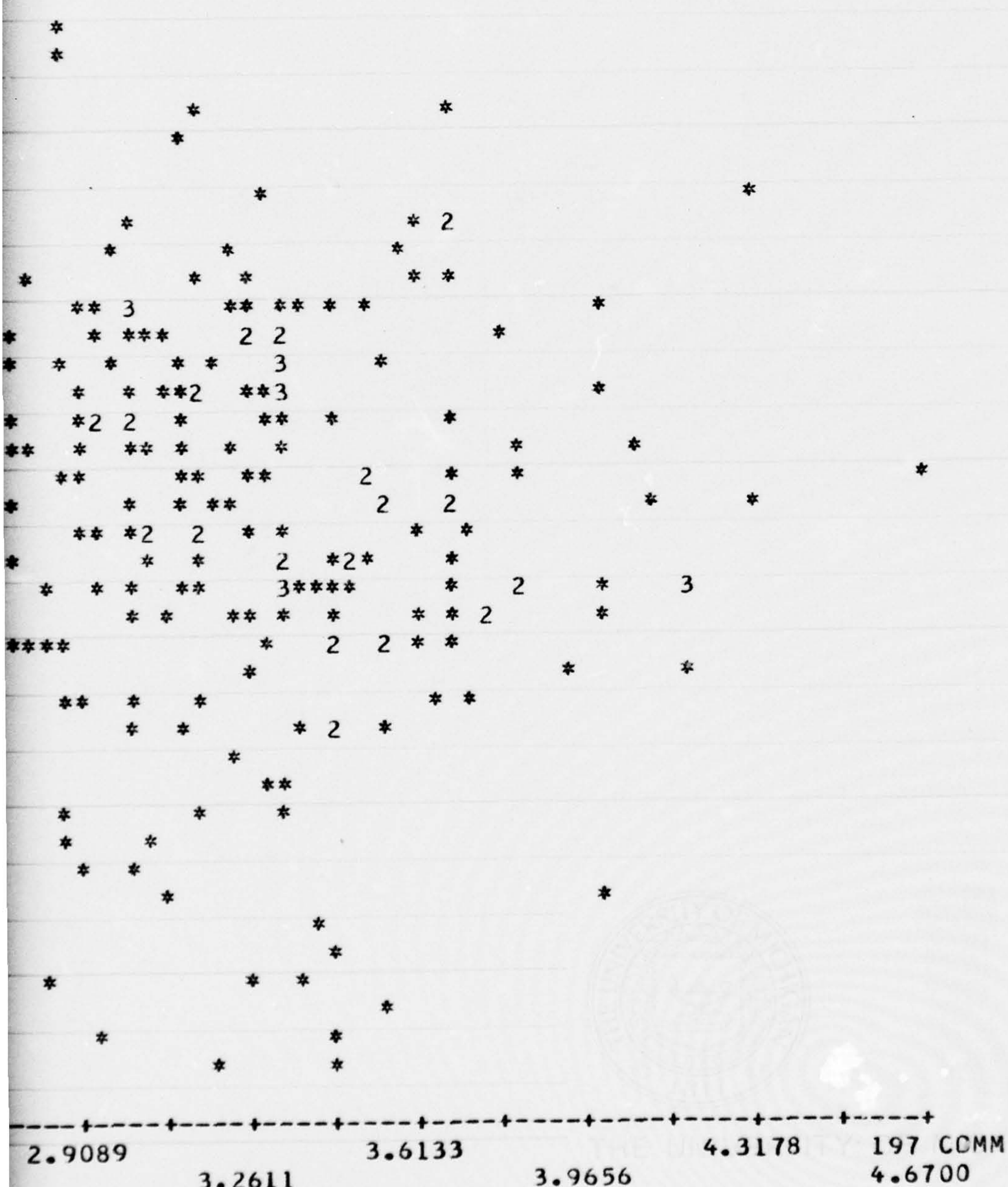

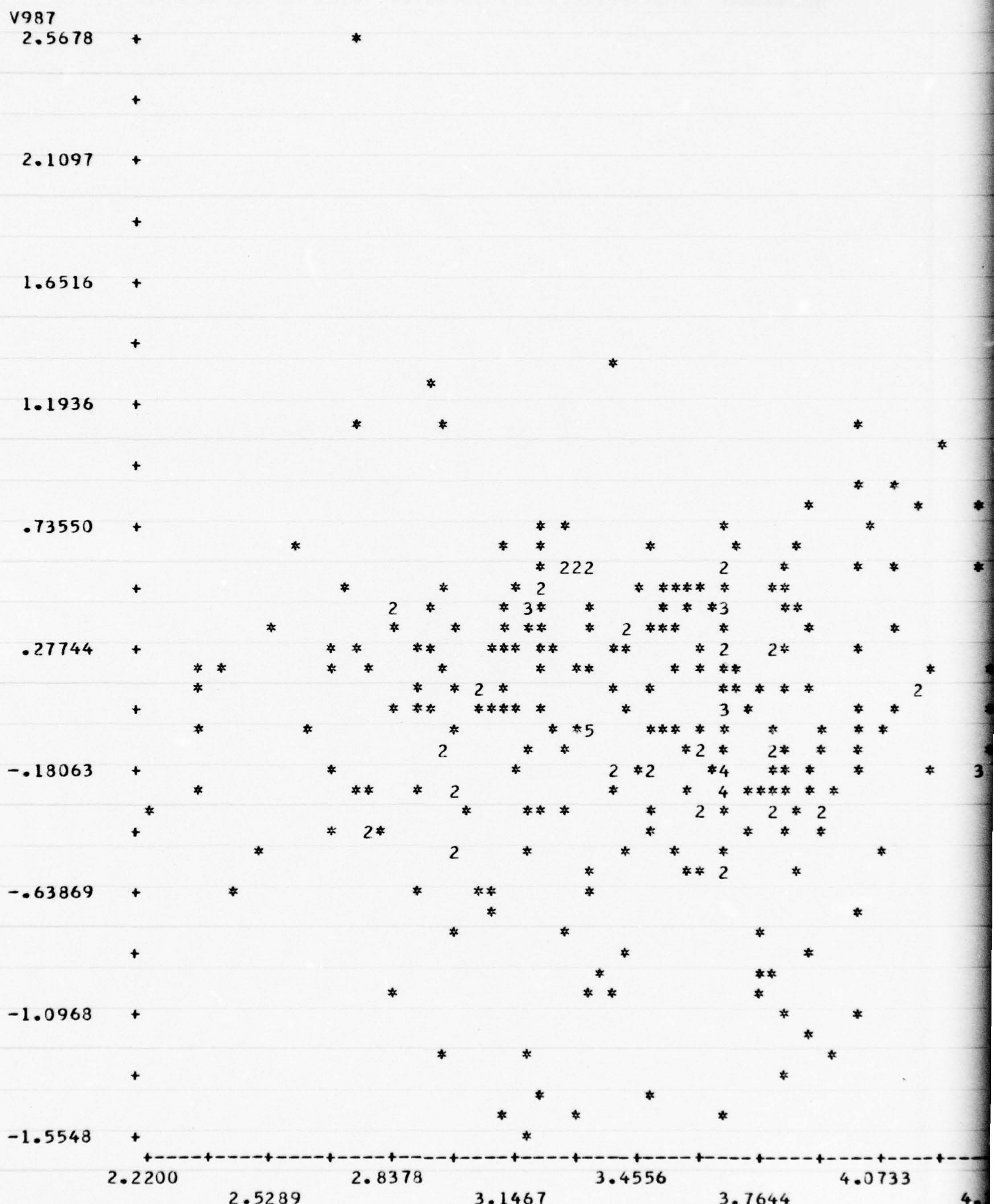
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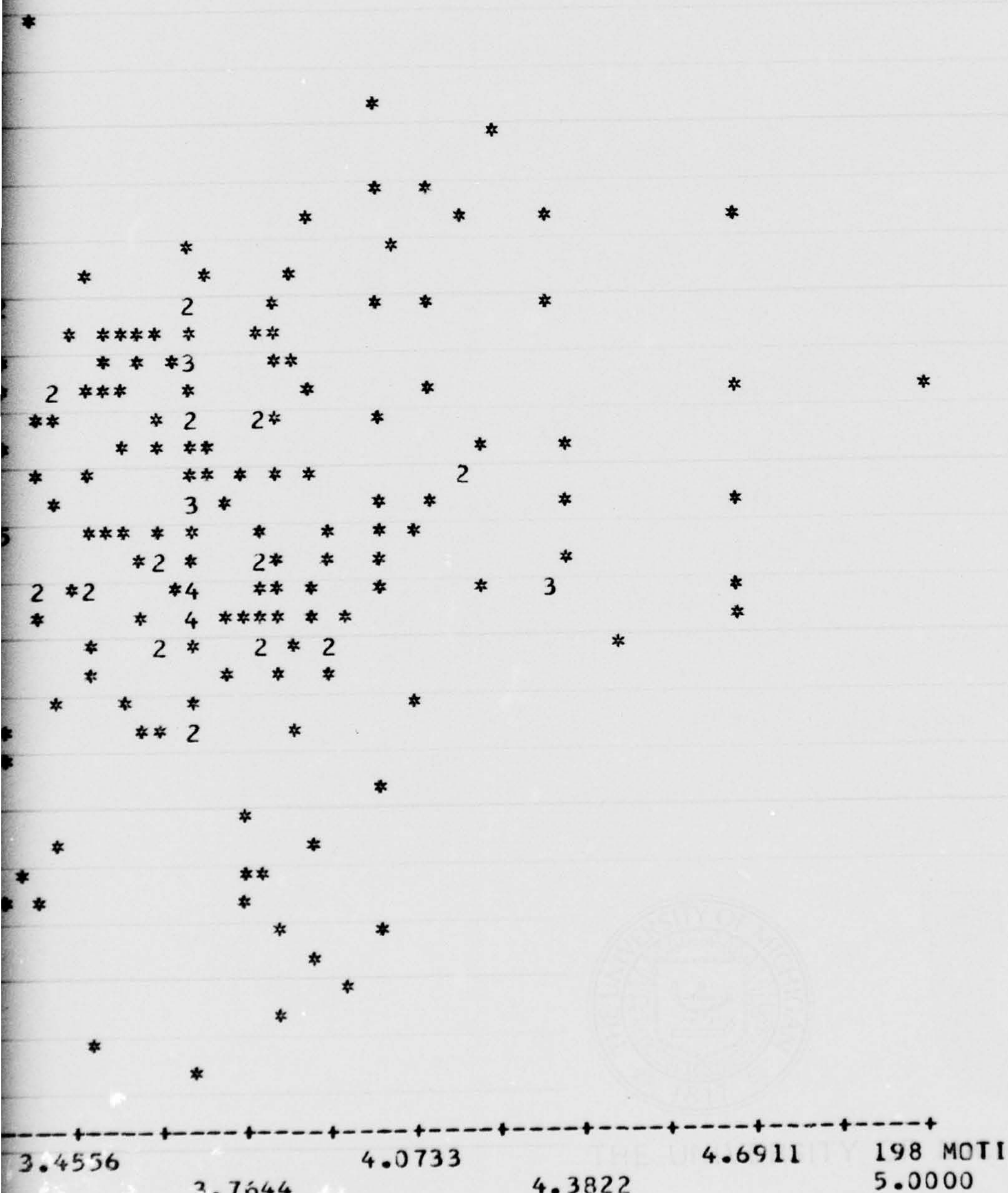
1

2



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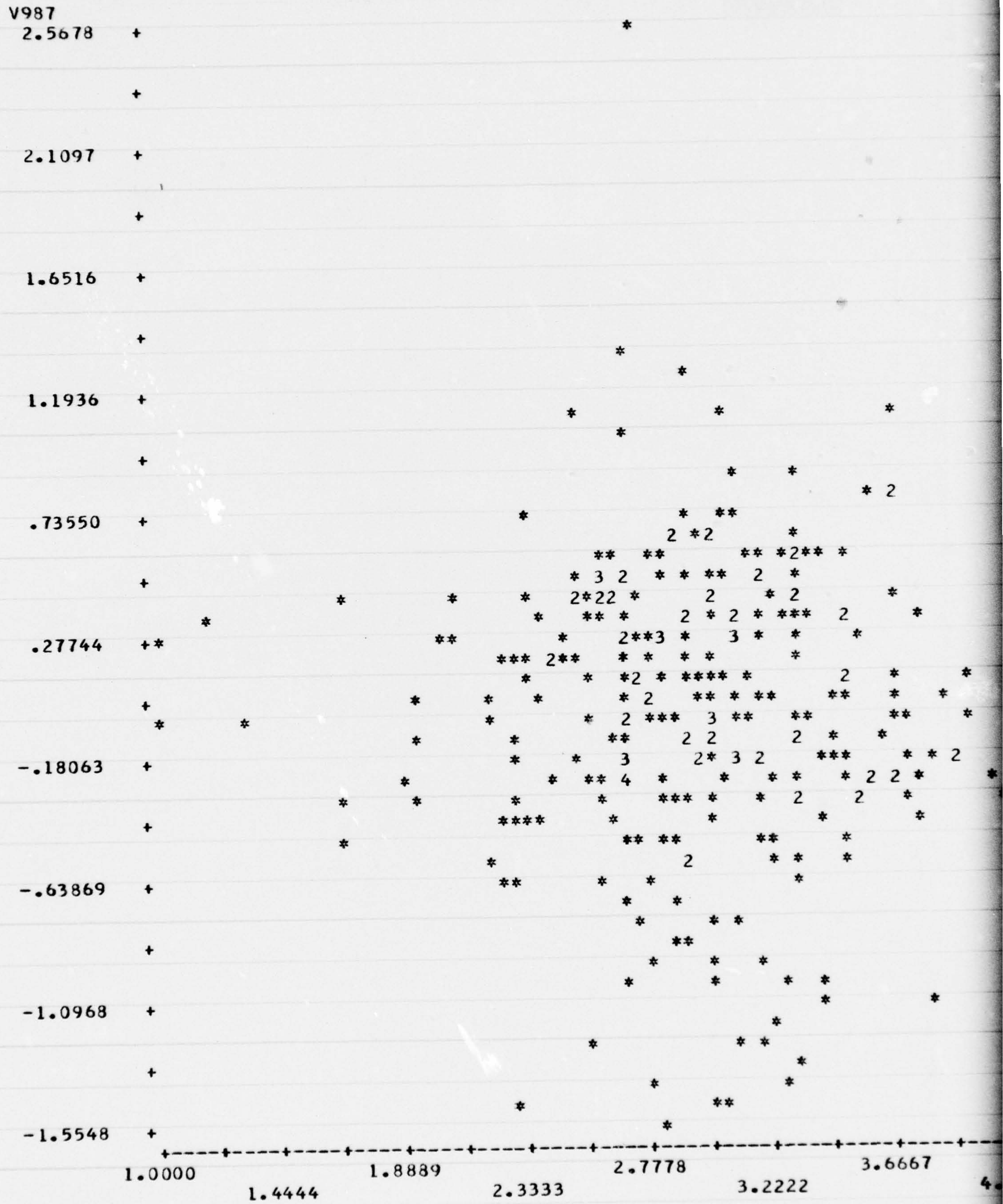

B-222

1

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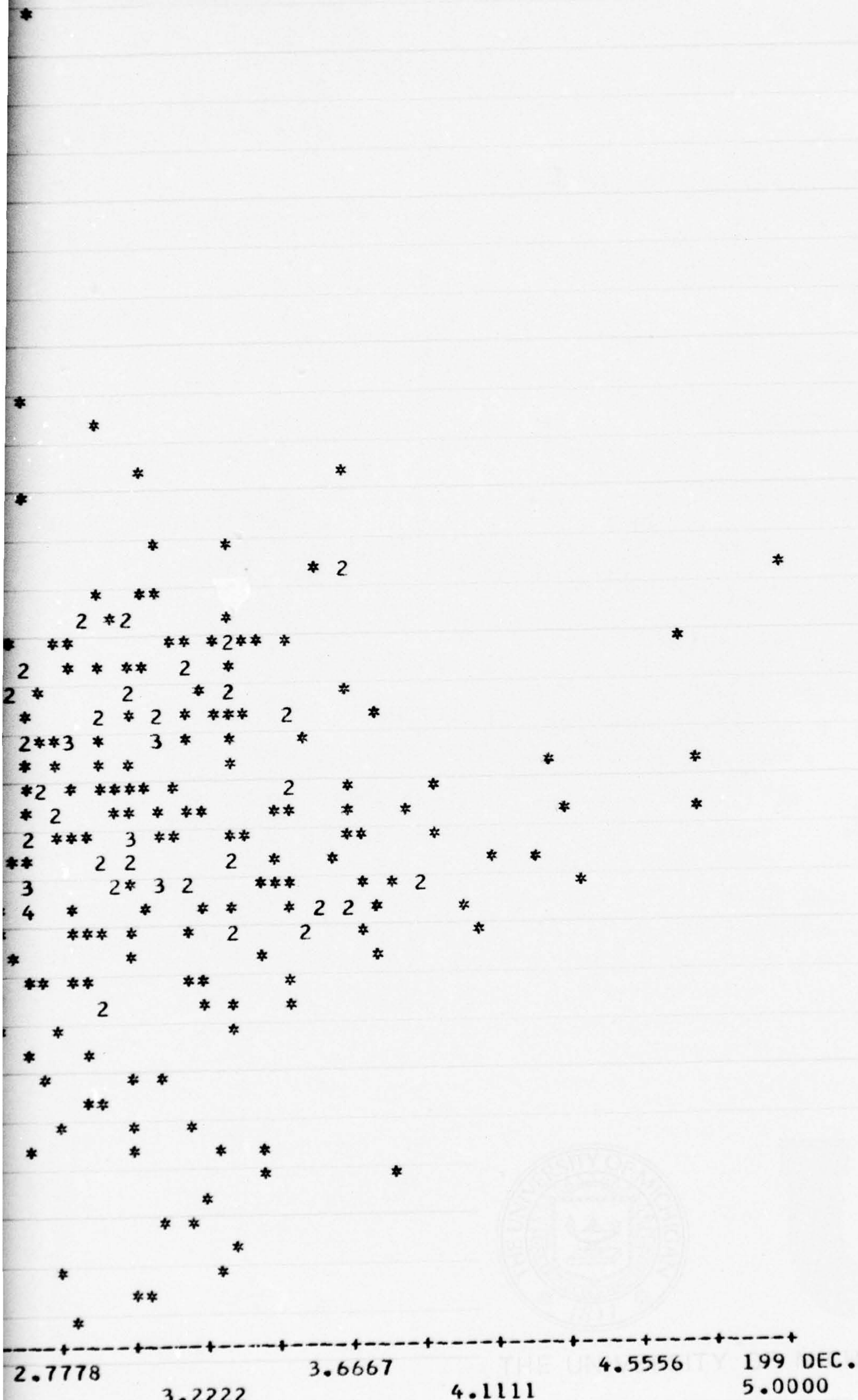

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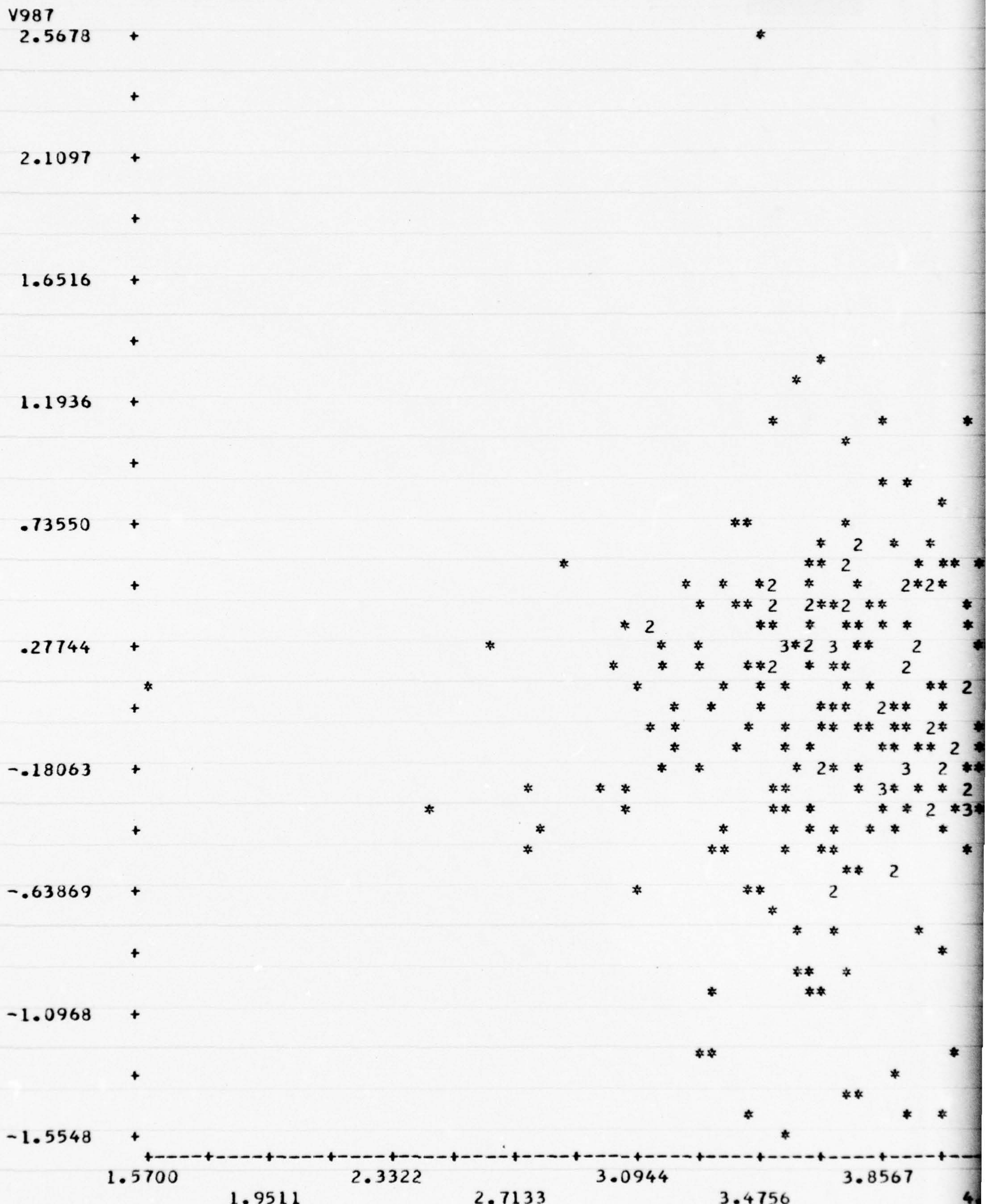

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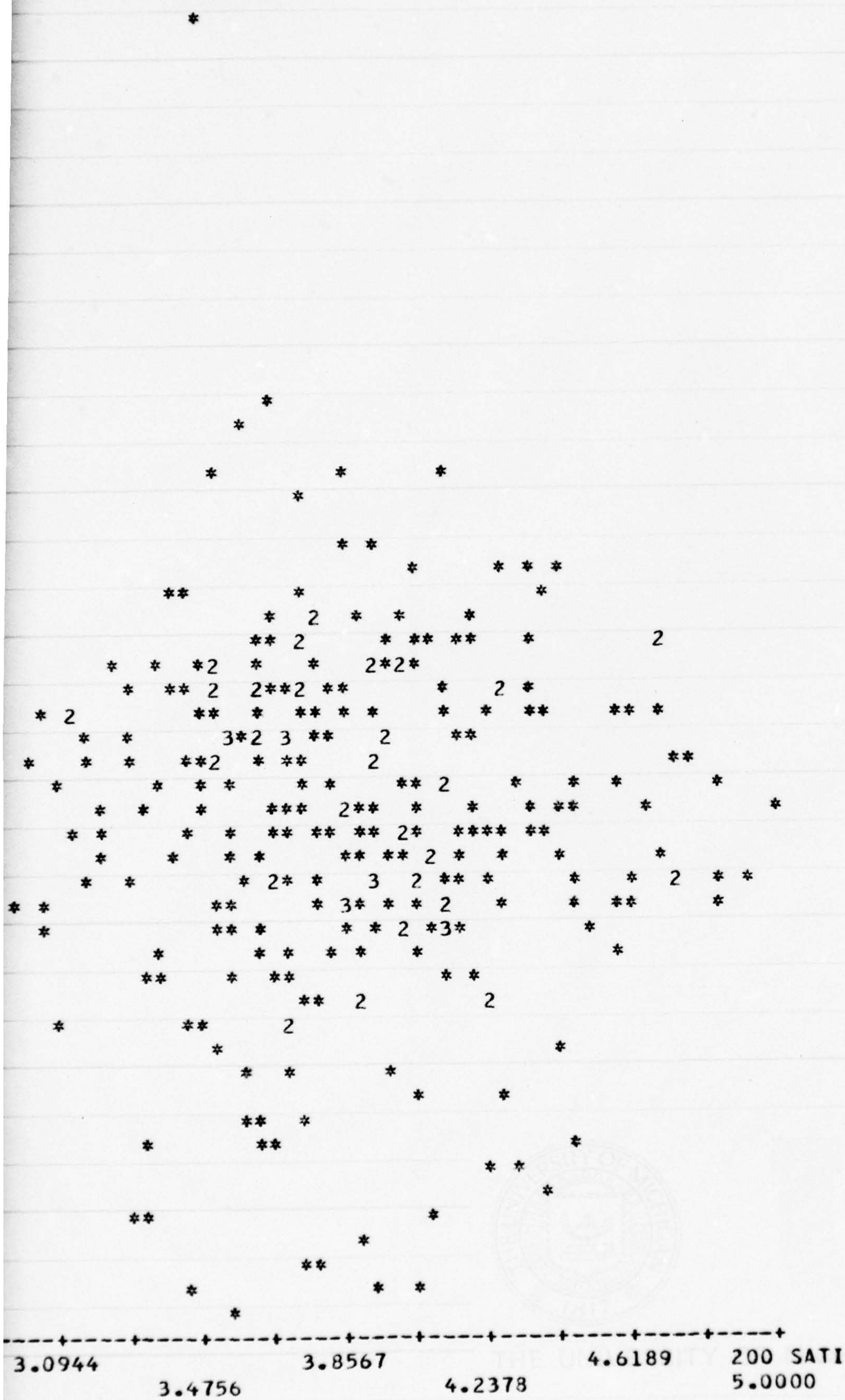

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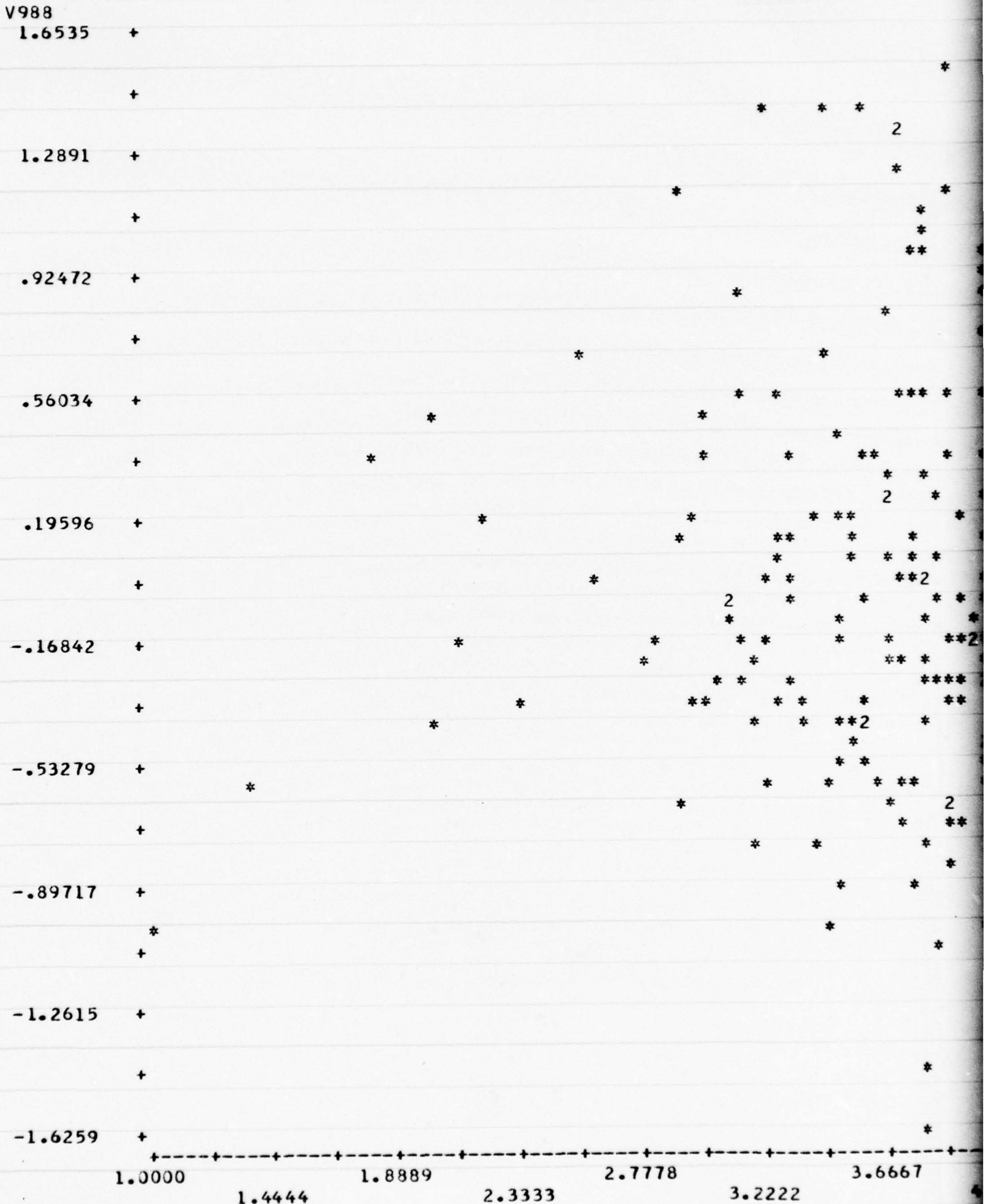

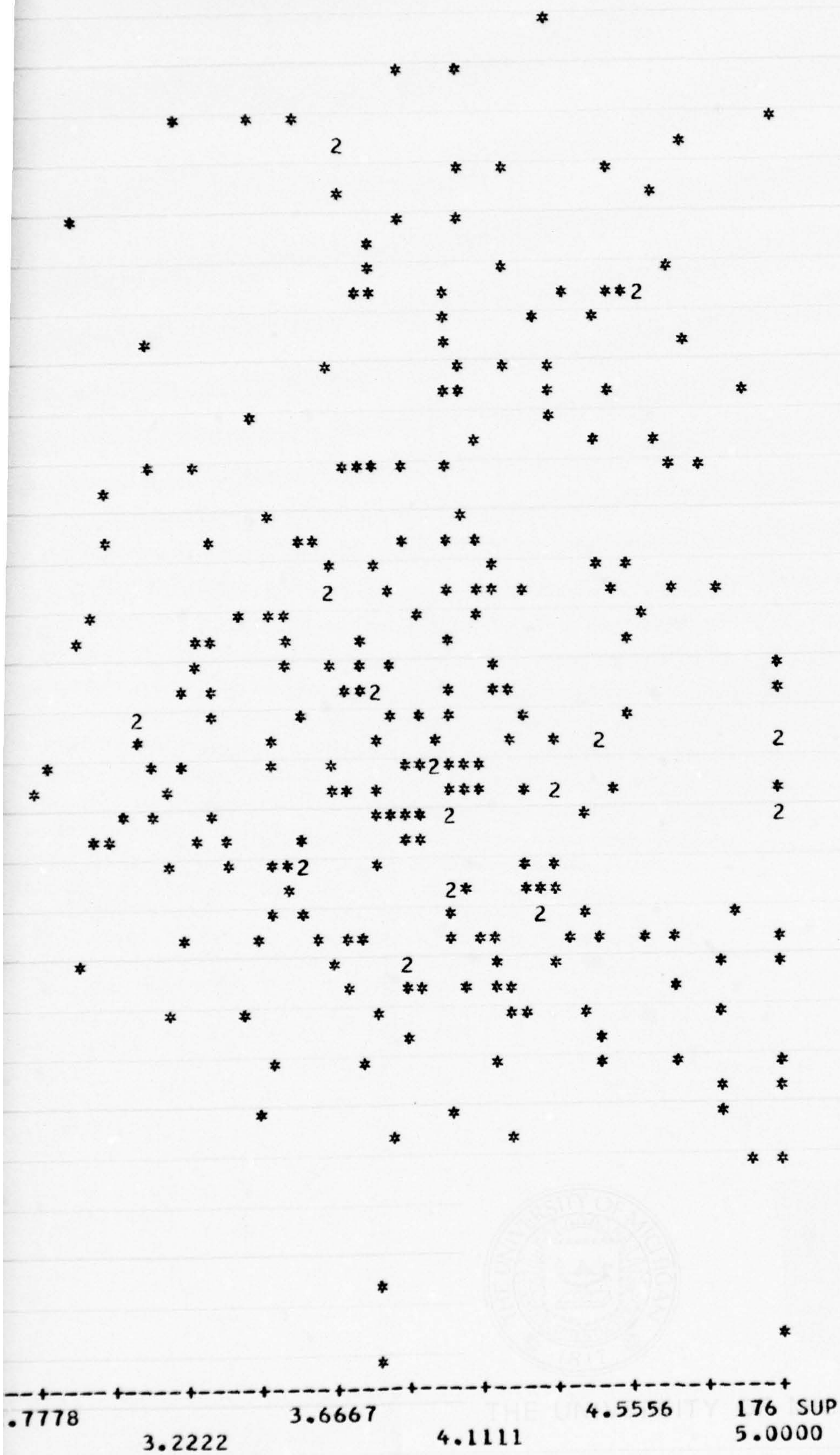
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3.6667
4.1111
4.5556
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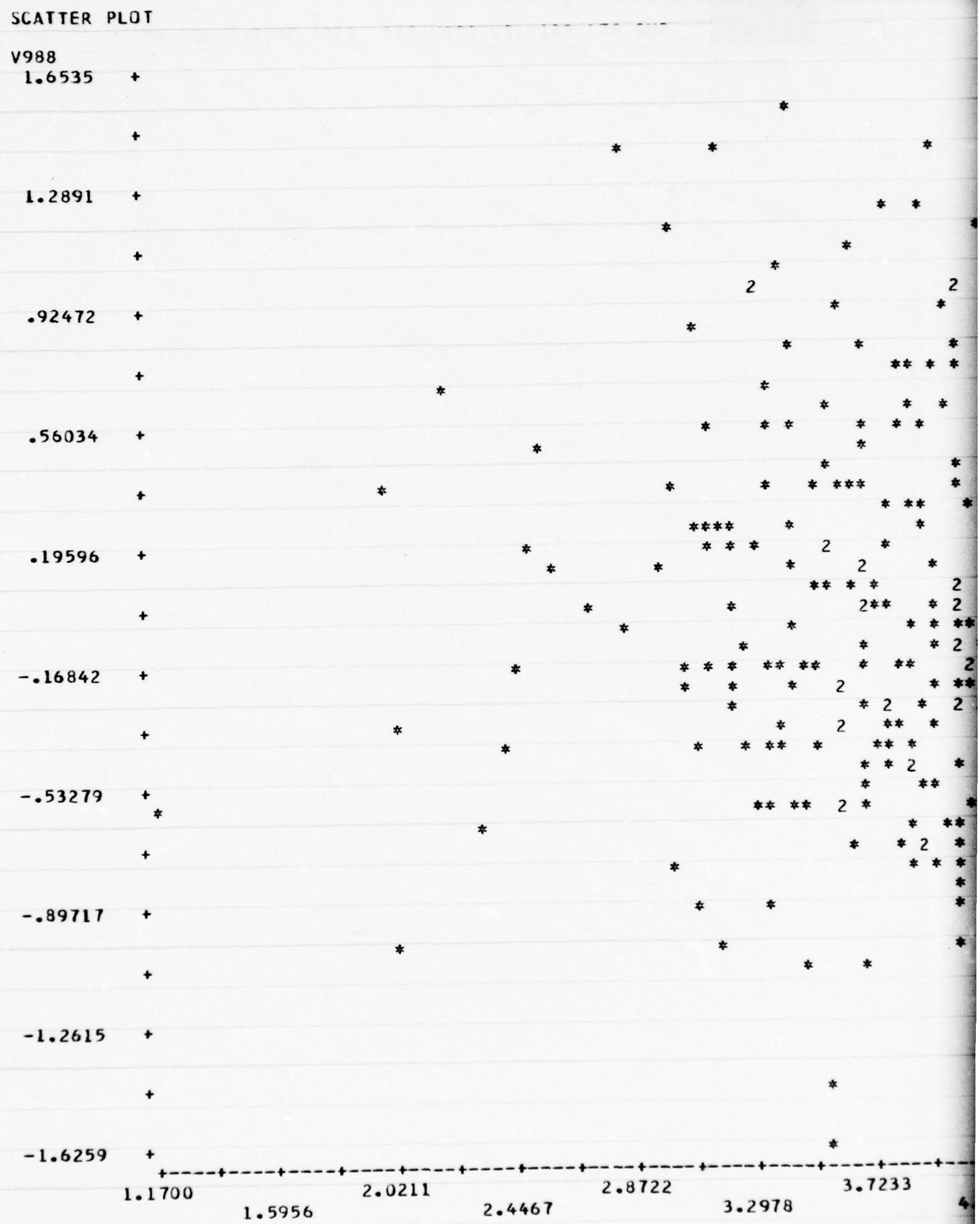
5.0000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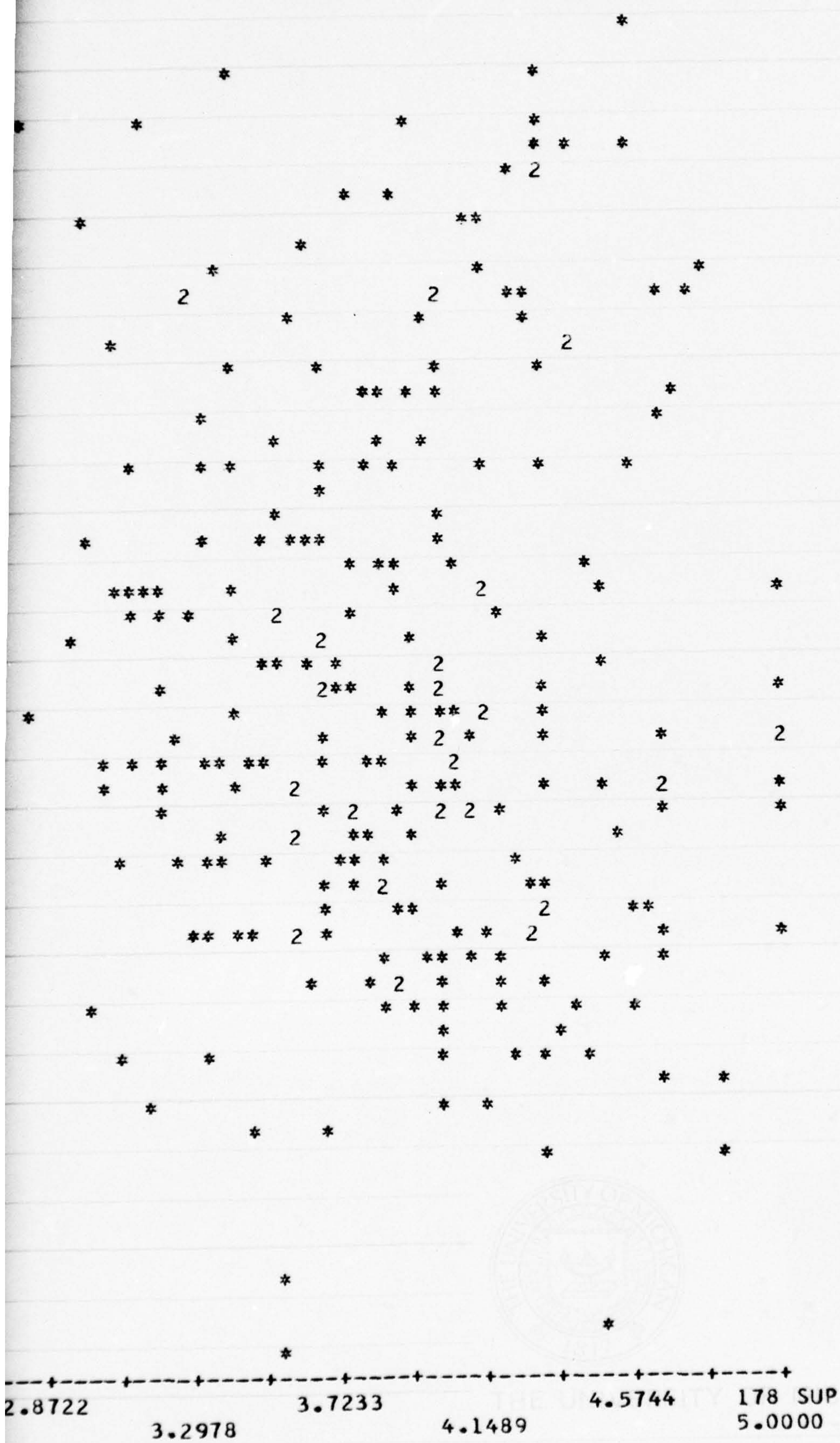
B-225



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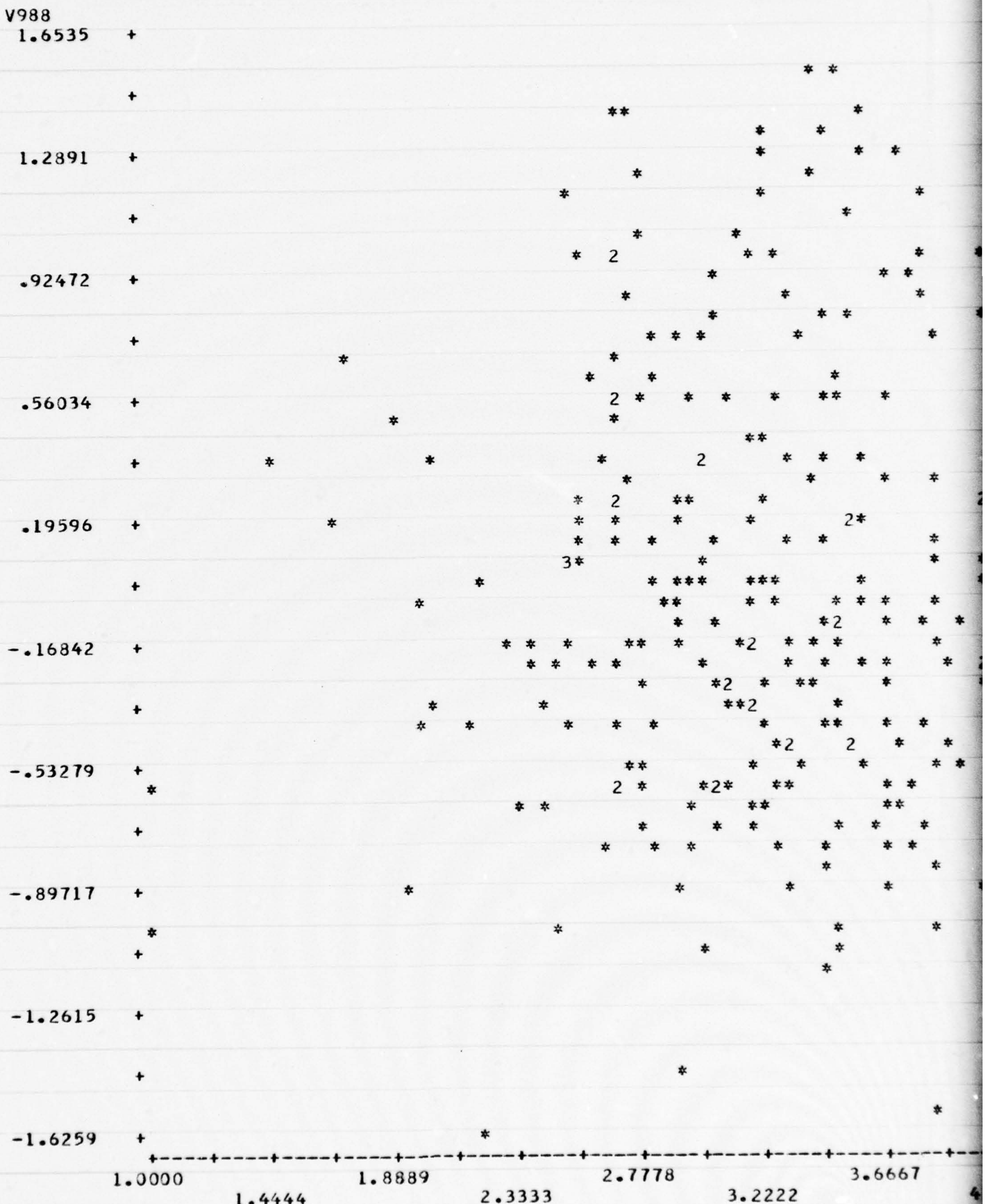

B-226

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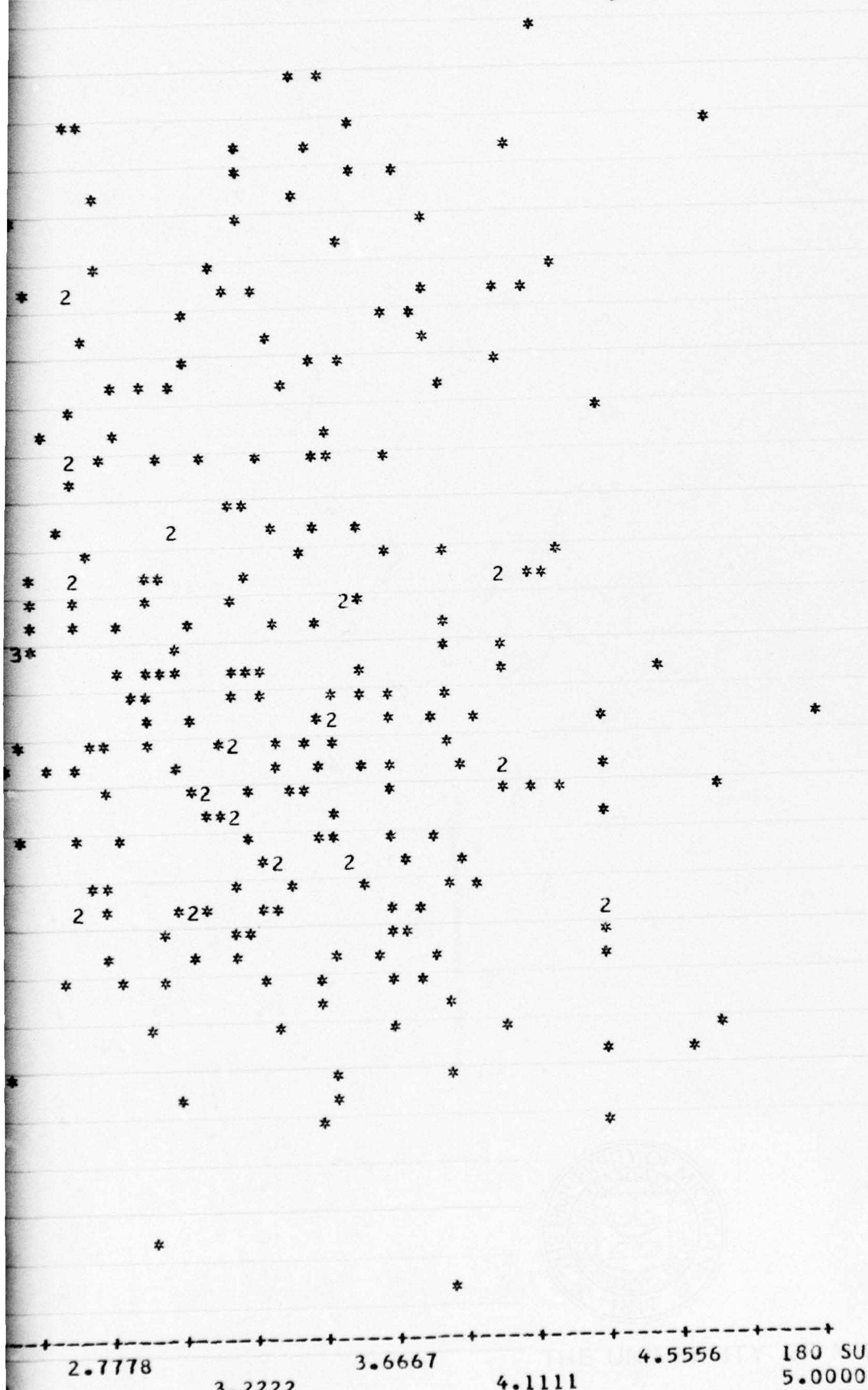

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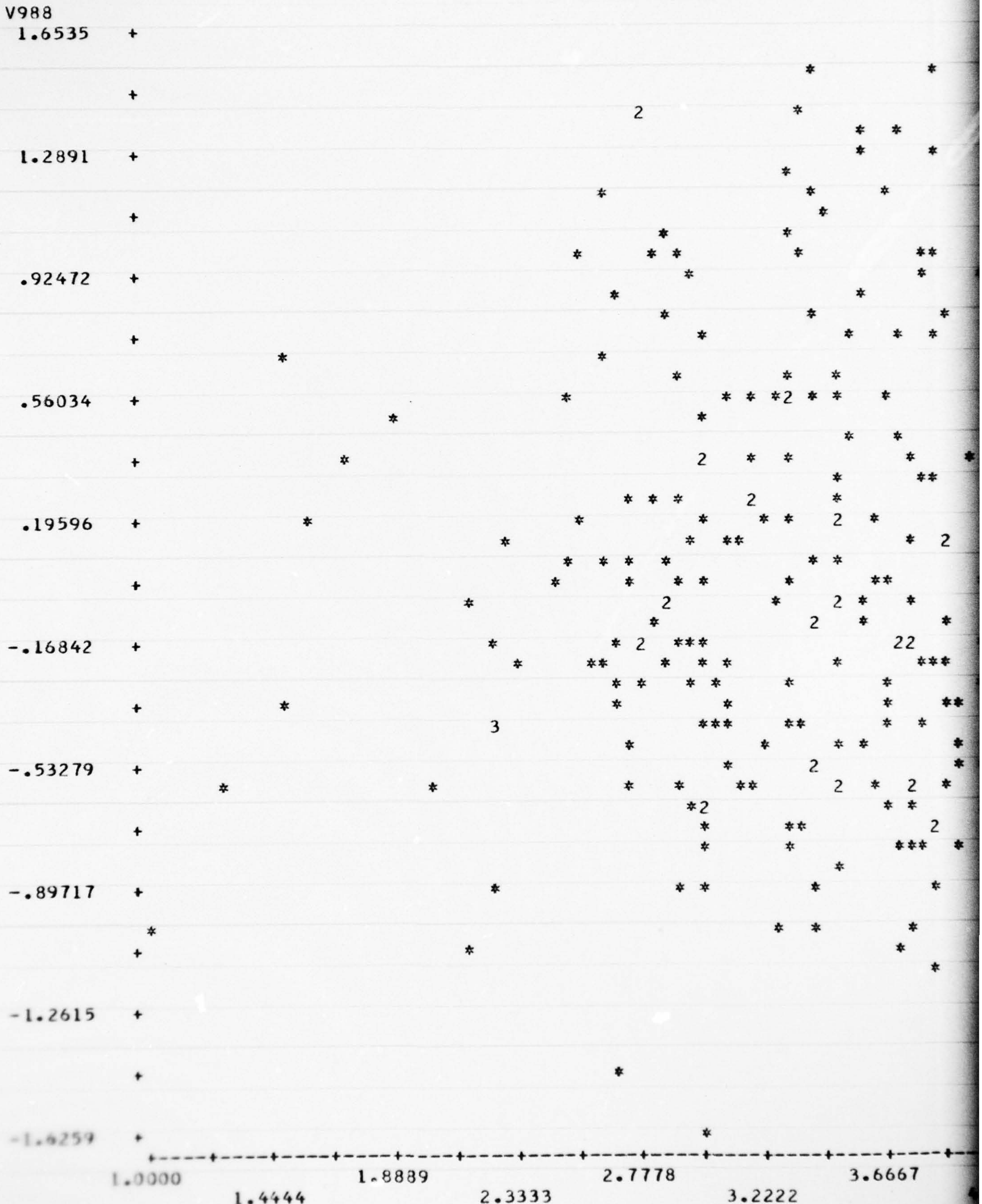

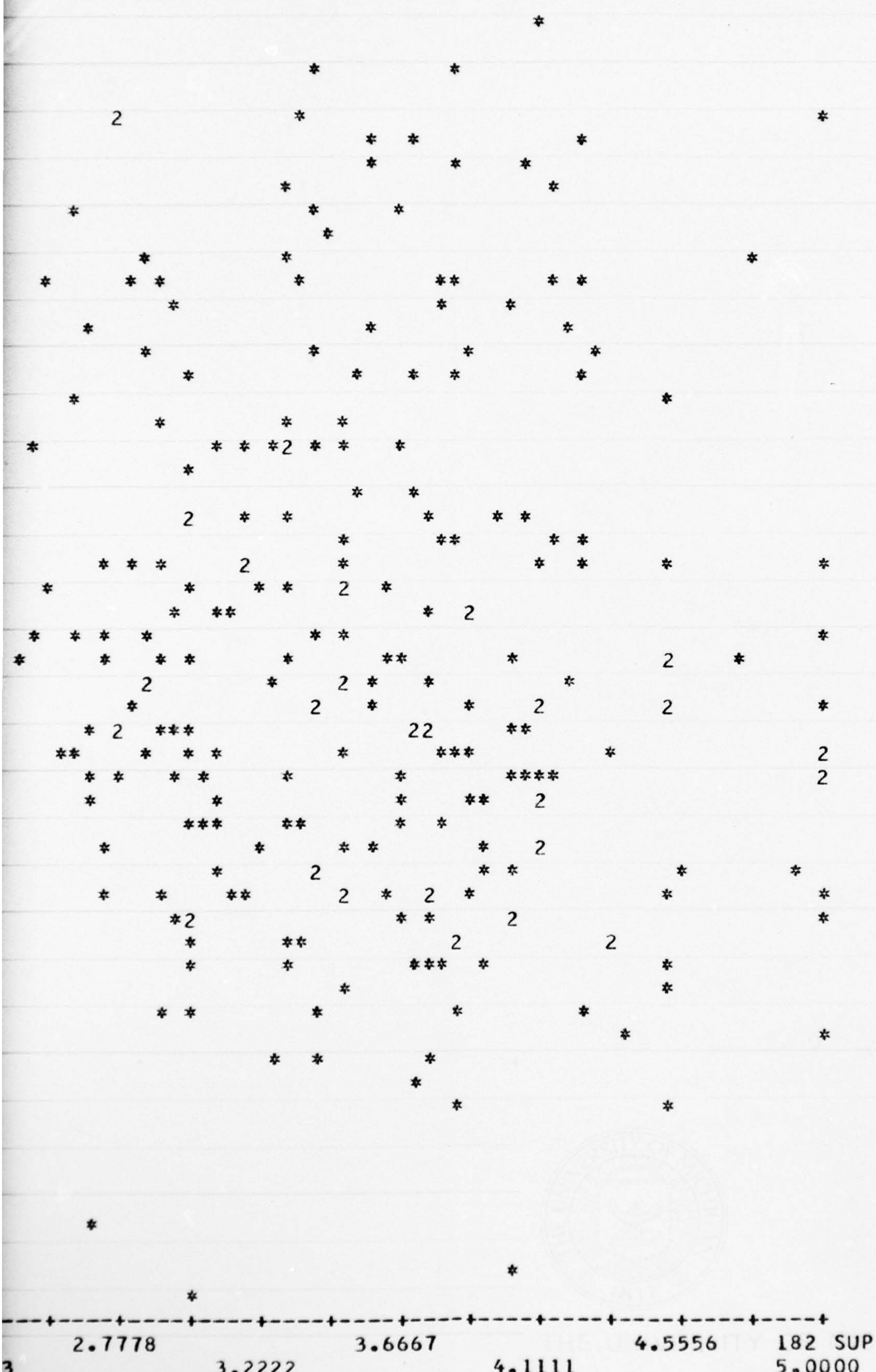
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4.5556
182 SUP
5.0000

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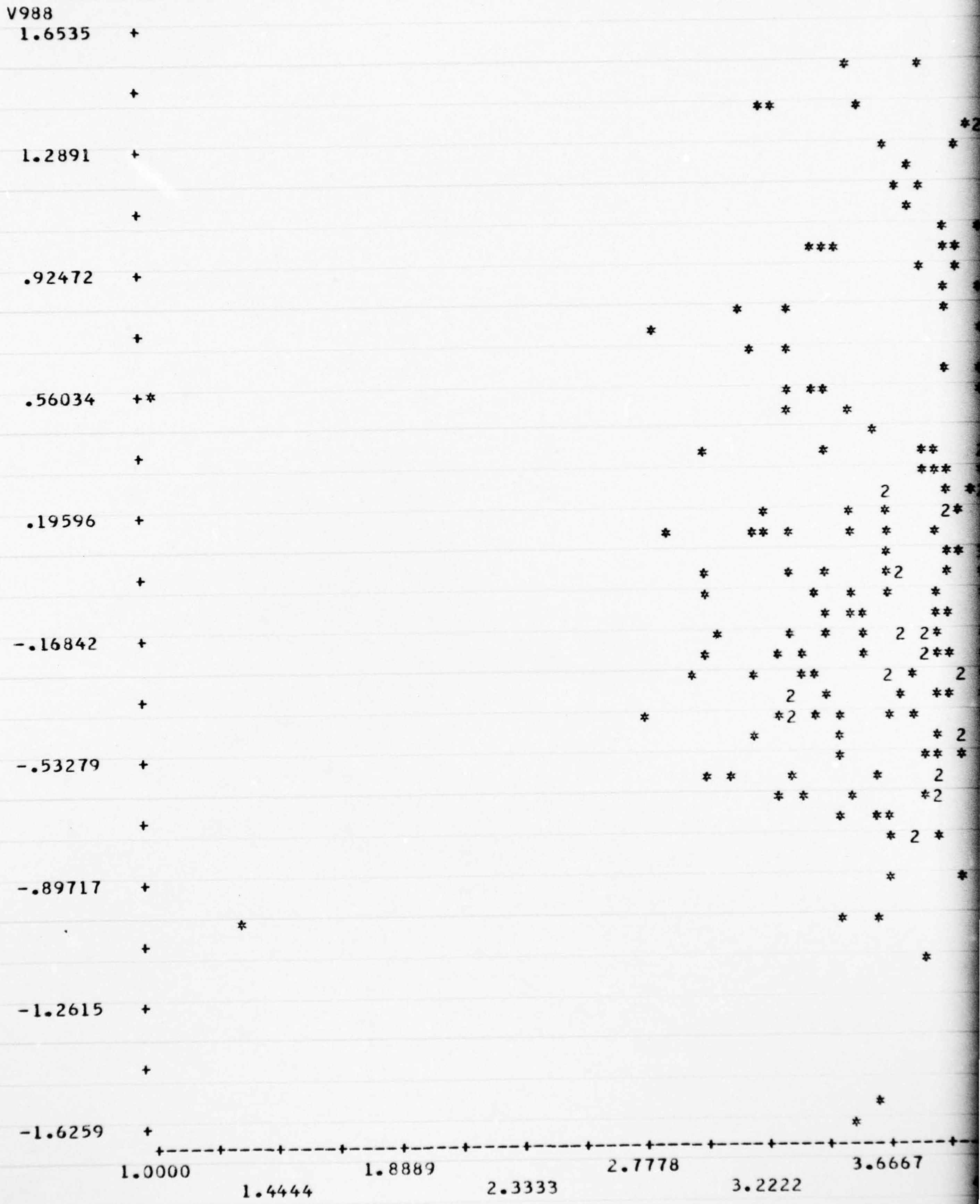

B-228

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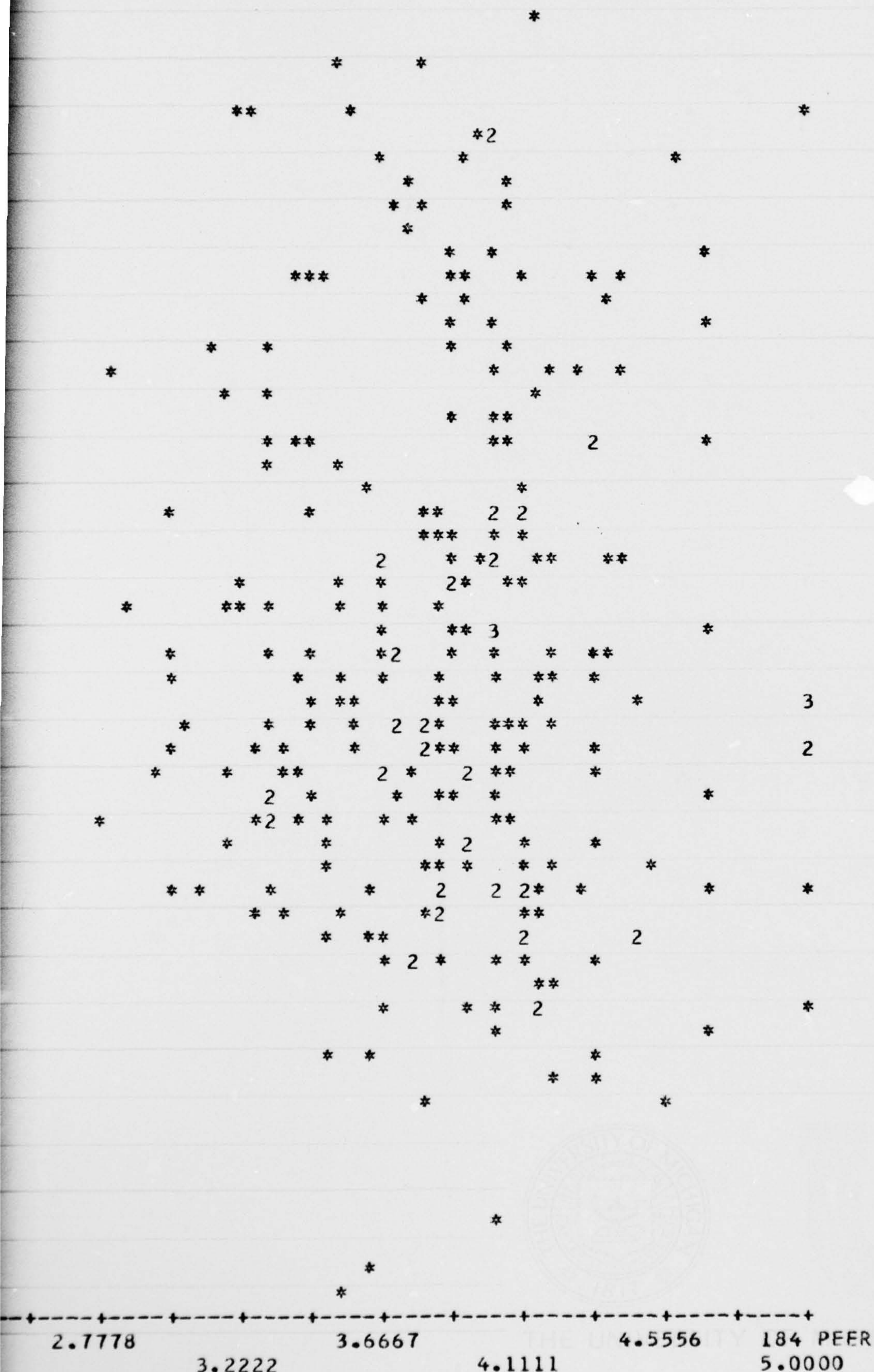

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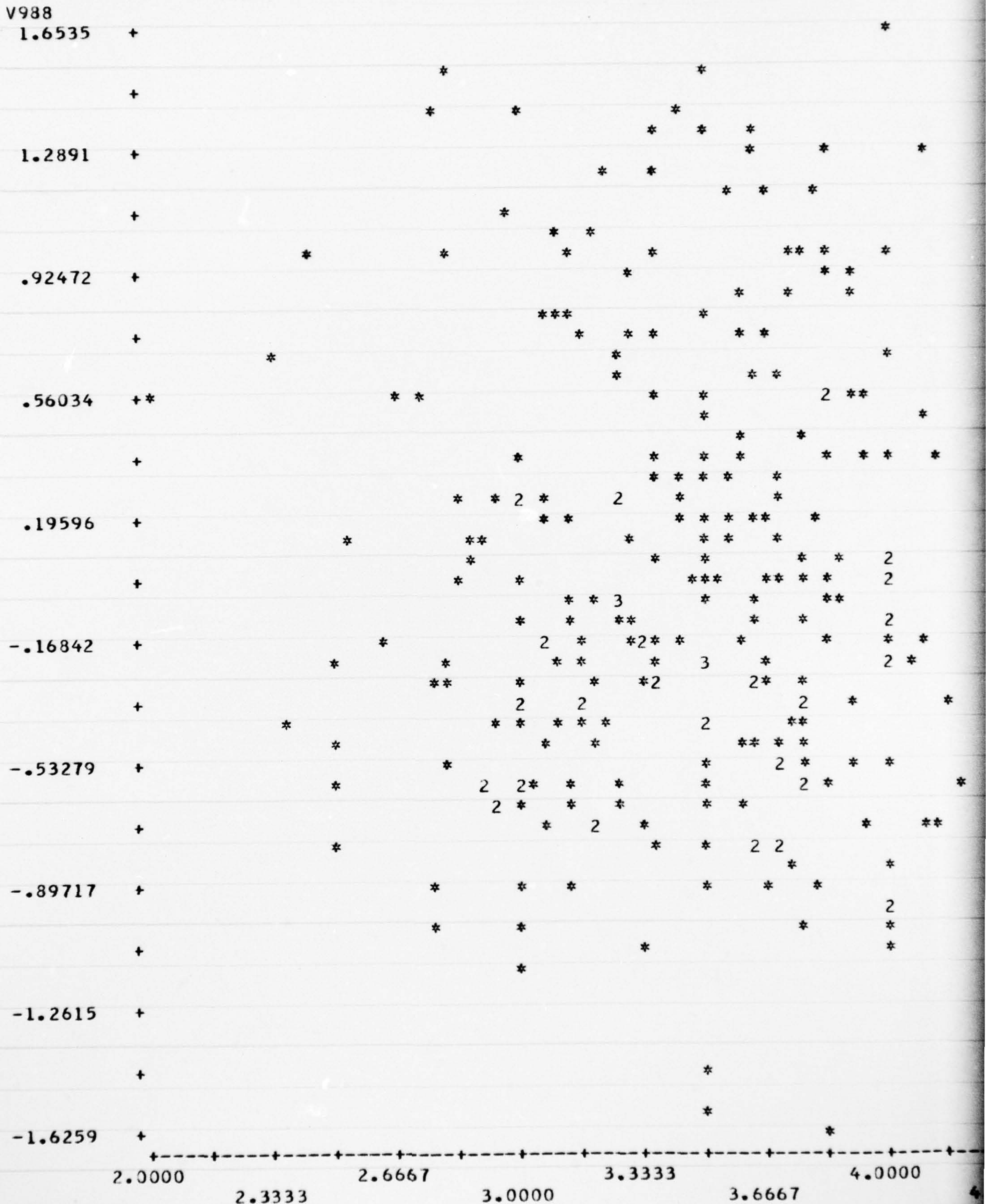

B-229

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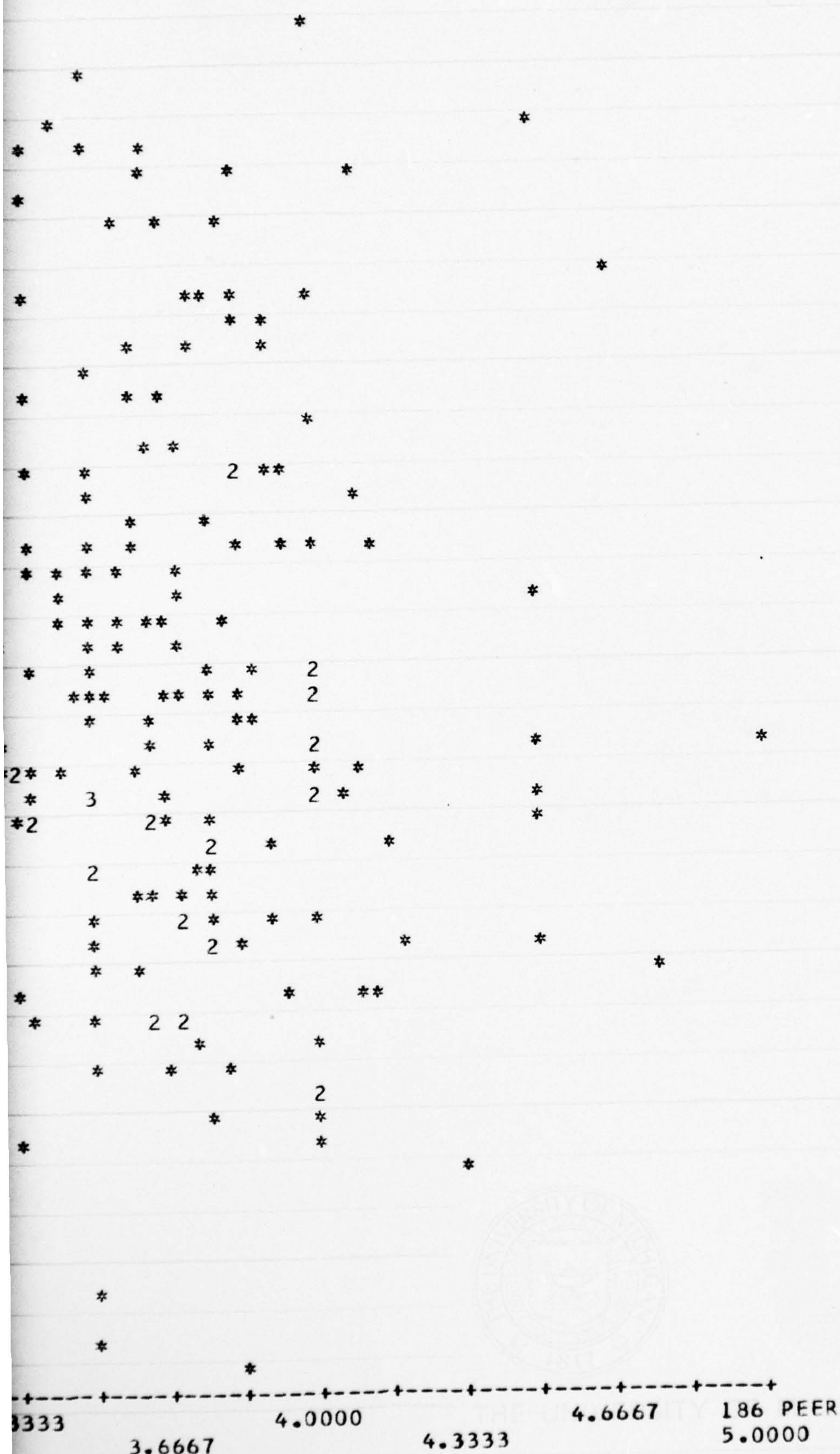

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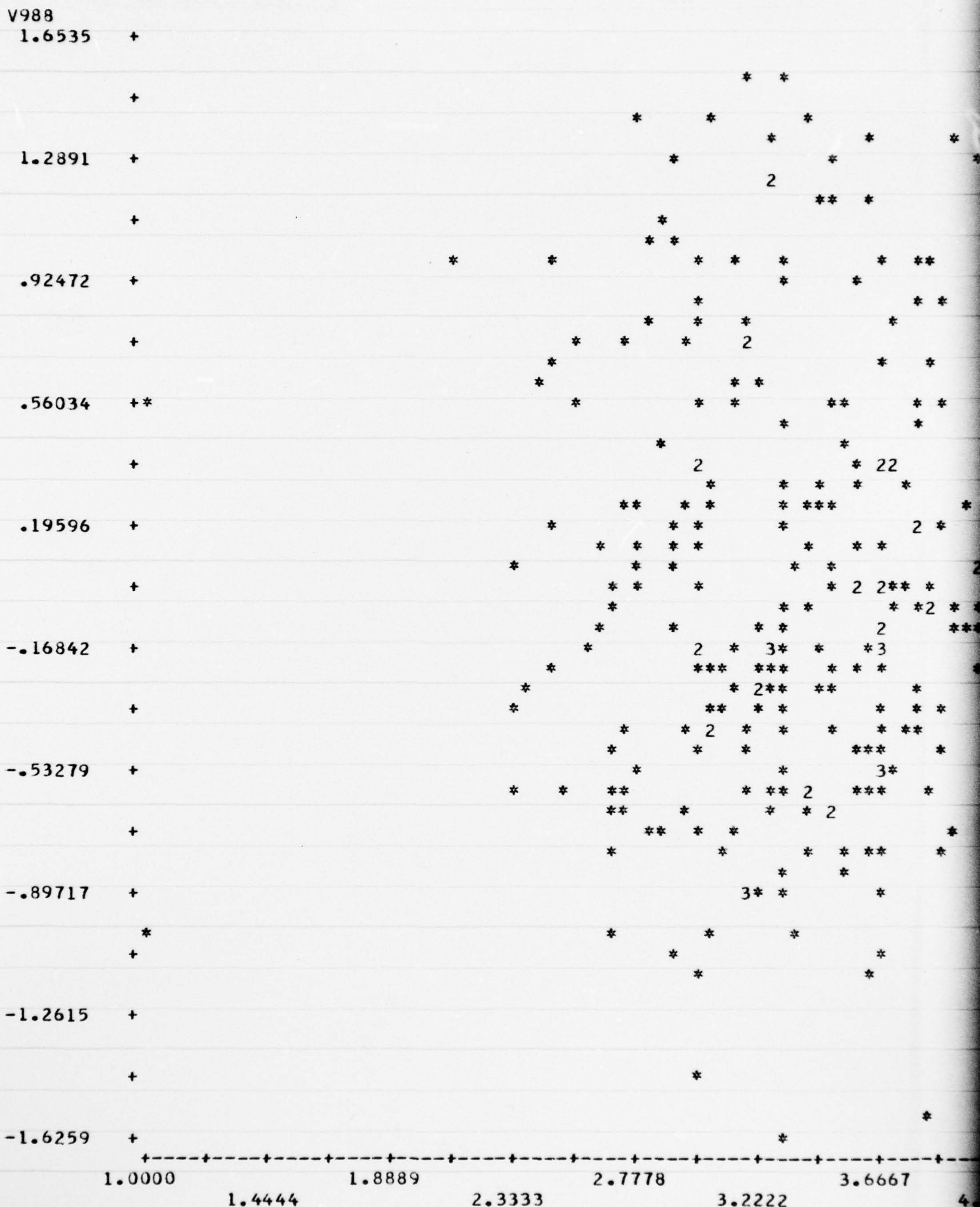

B-230

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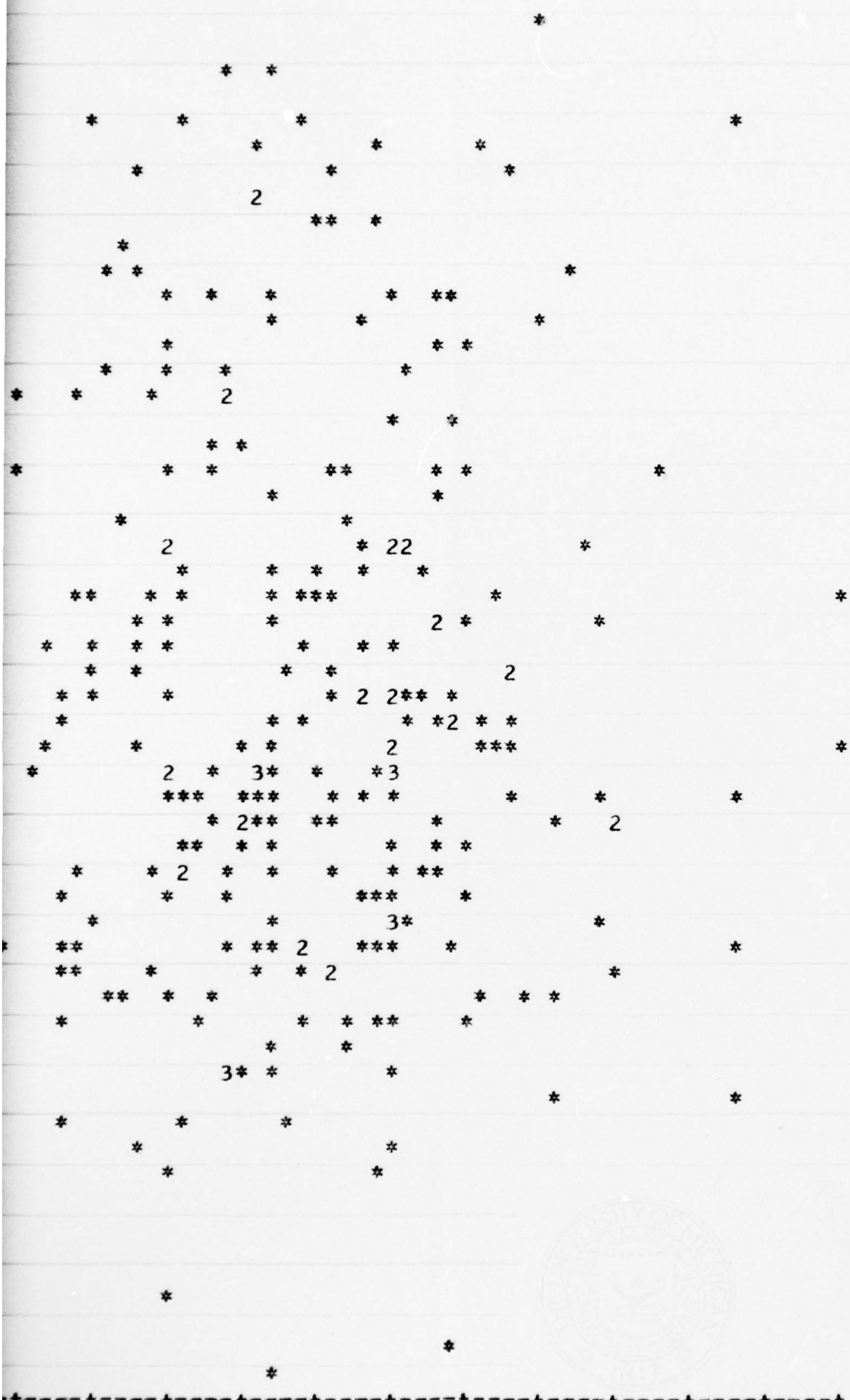

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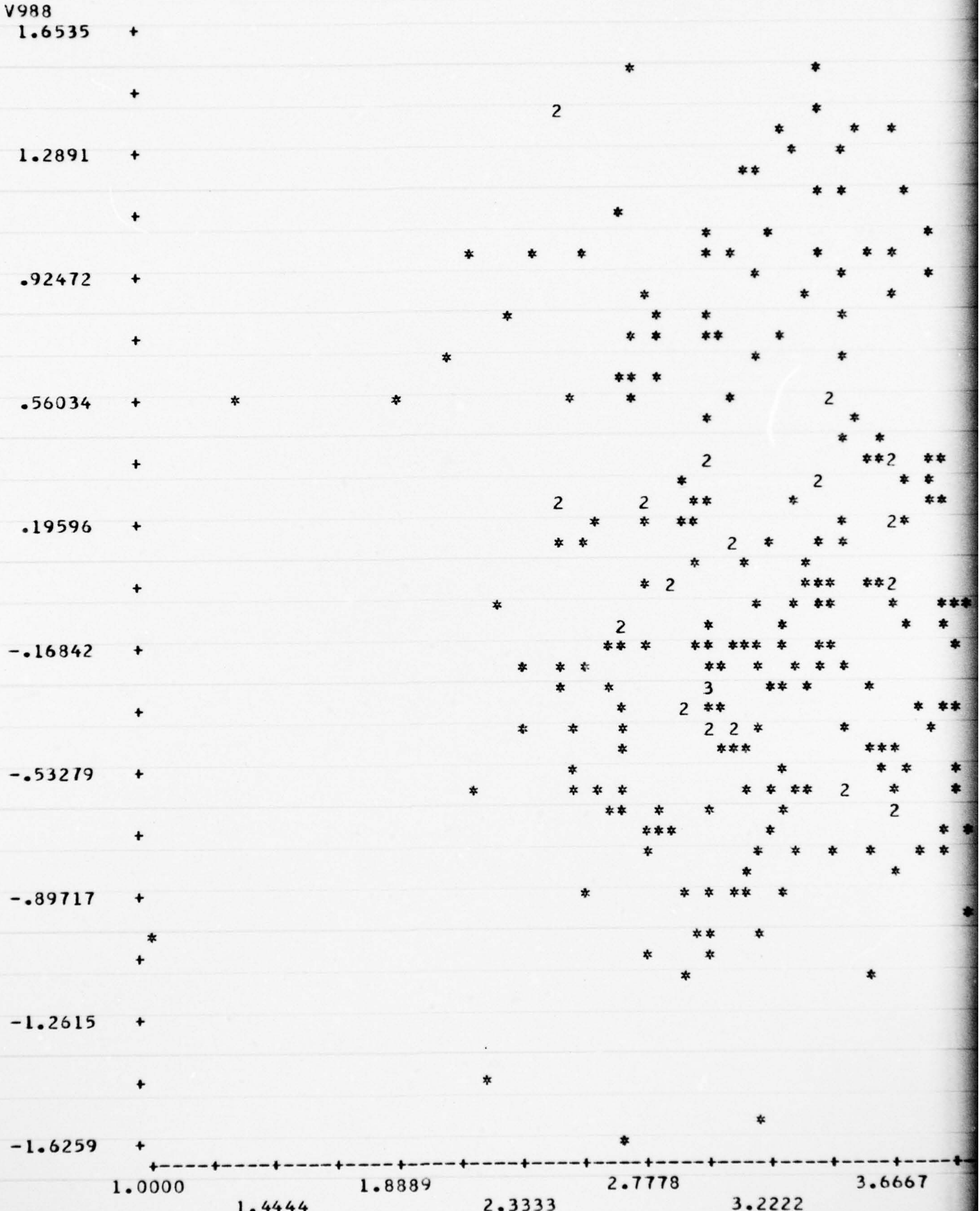

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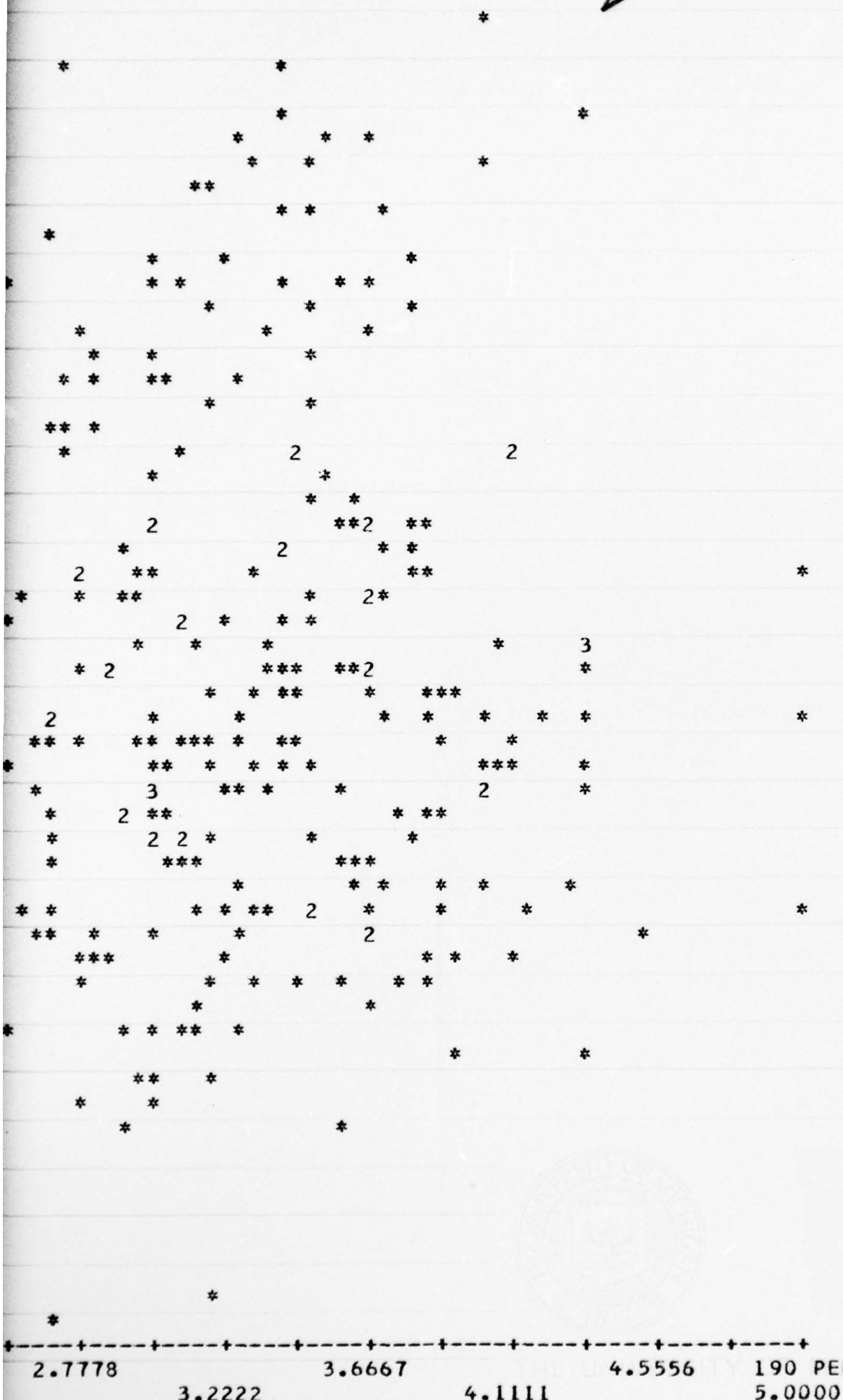

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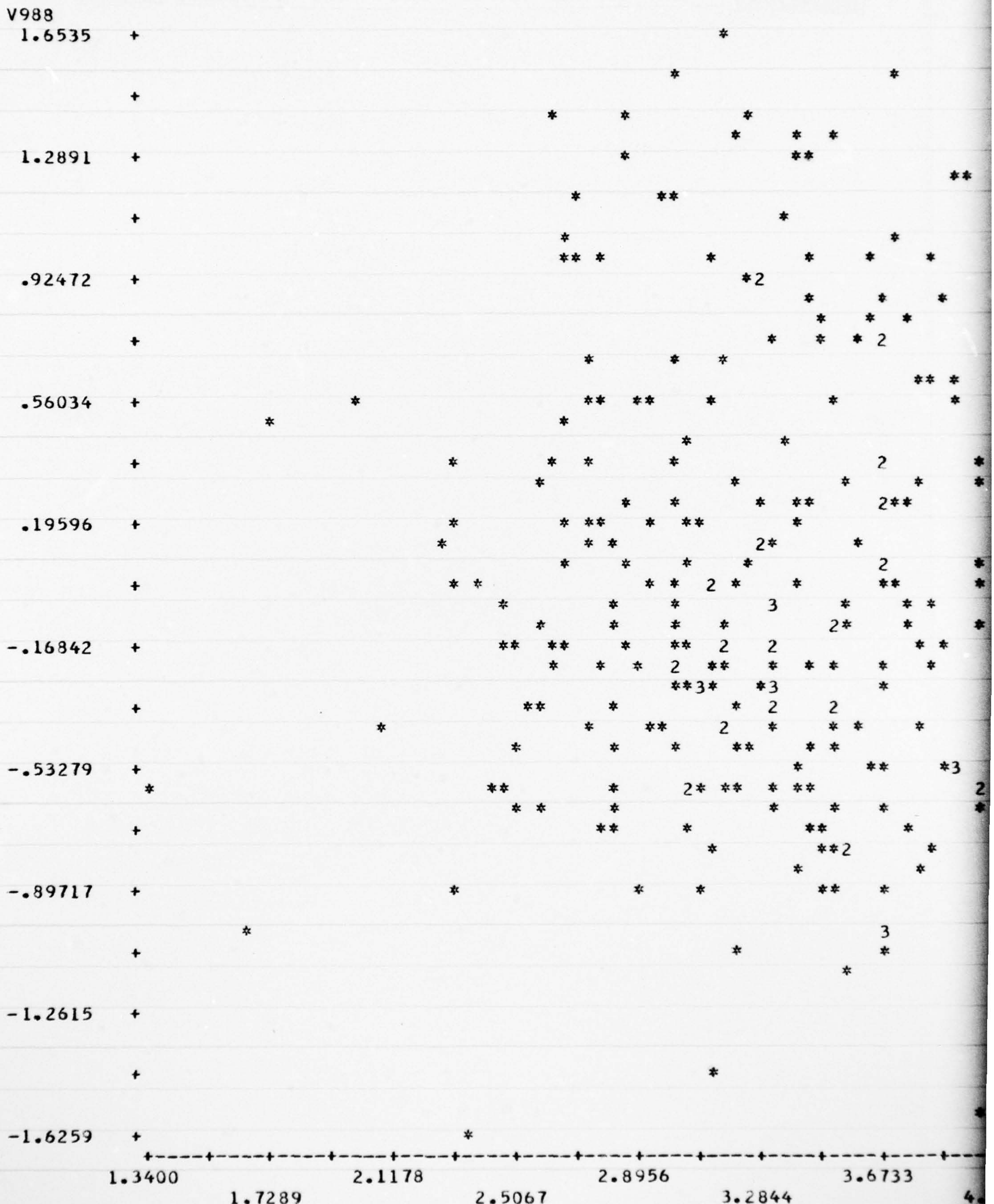

B-232

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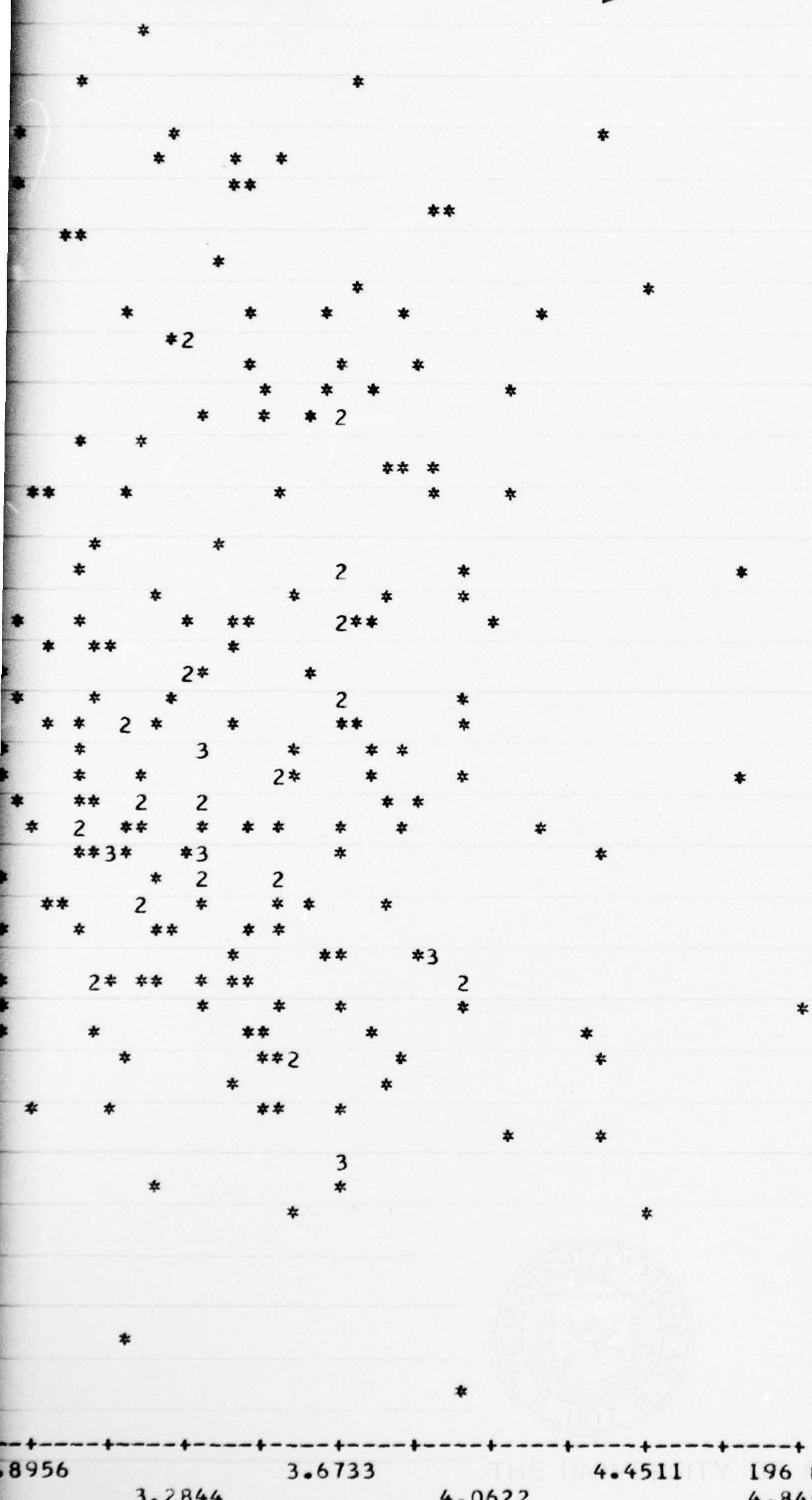

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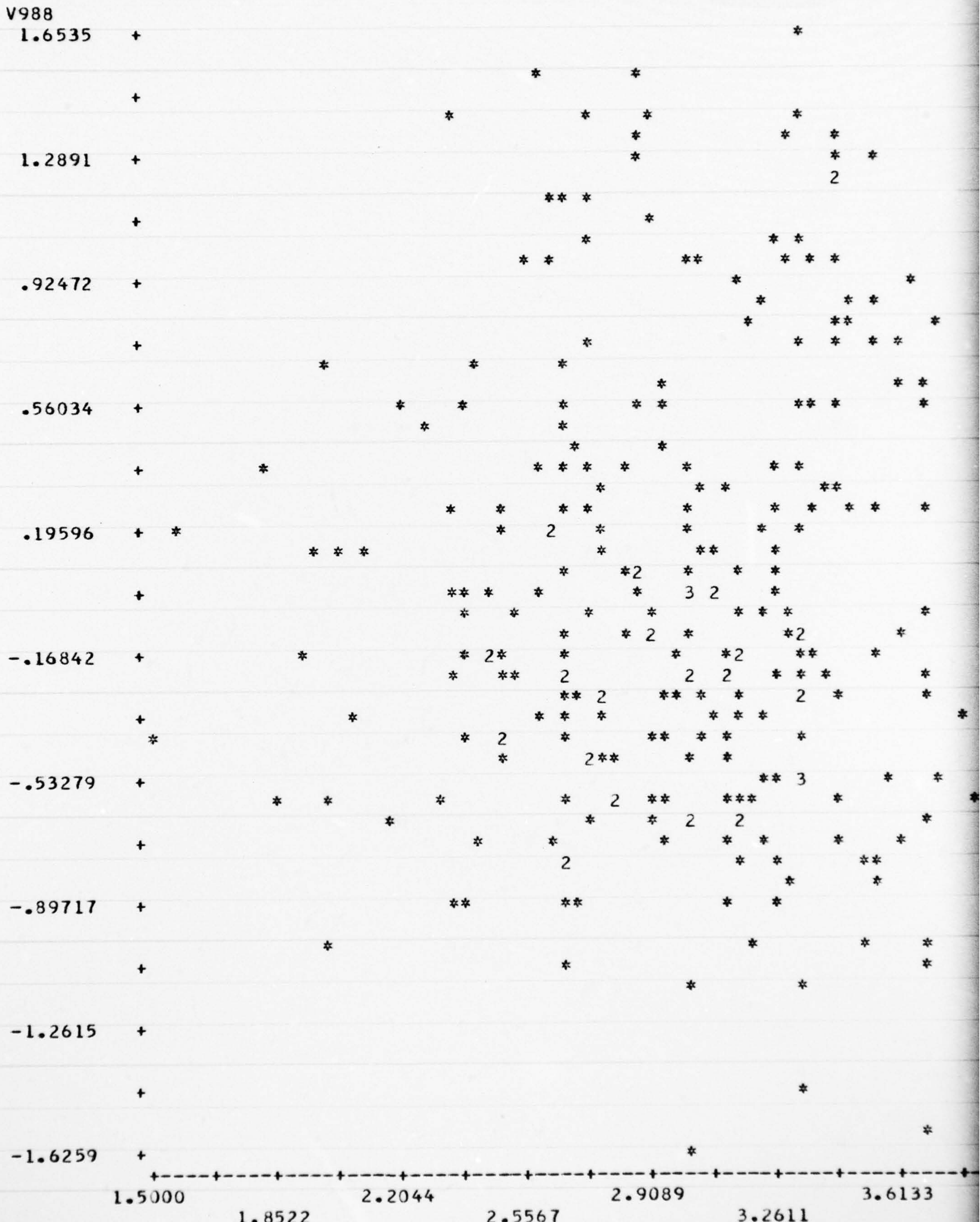

B-233

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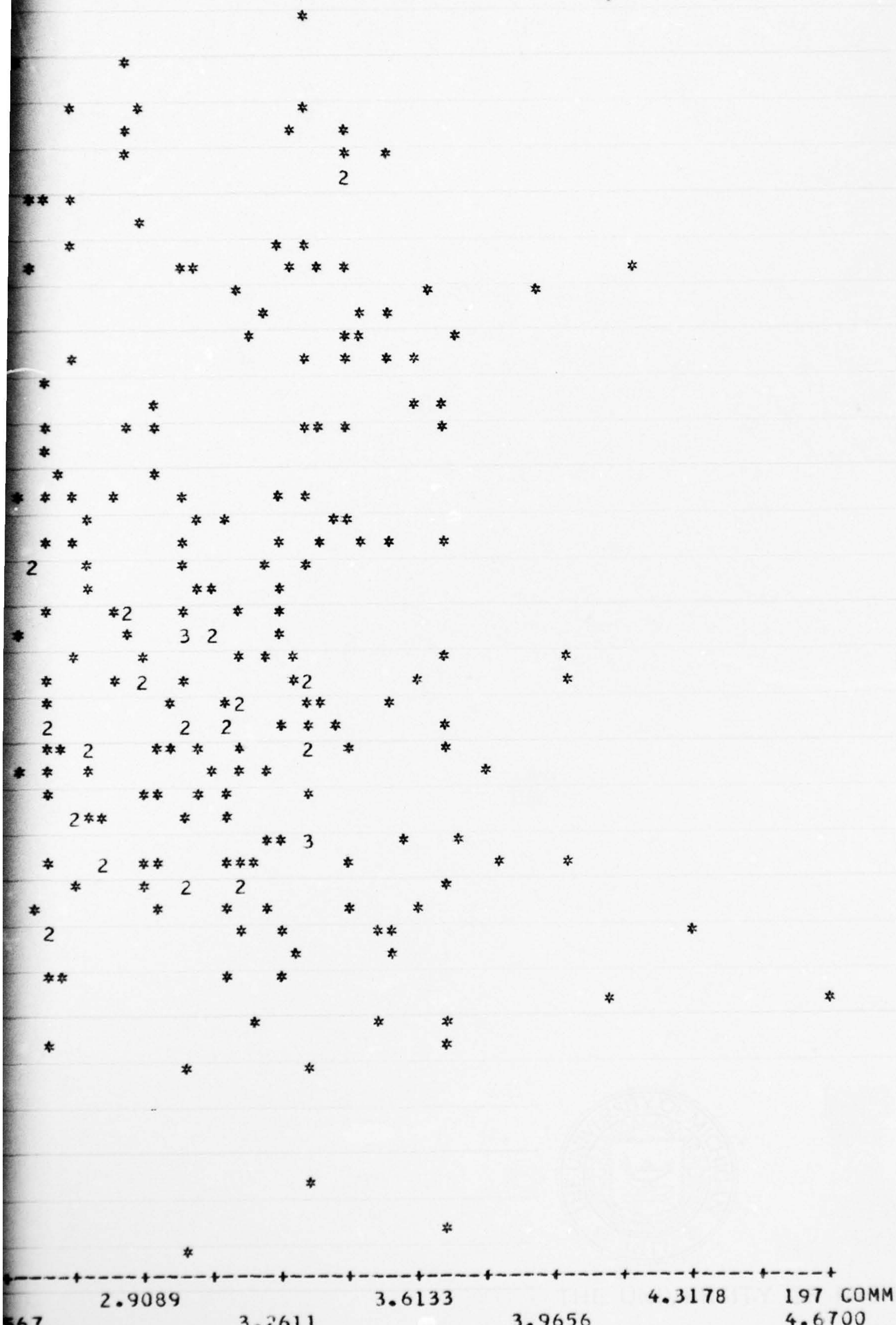

AD-A045 068 MICHIGAN UNIV ANN ARBOR INST FOR SOCIAL RESEARCH F/G 5/9
FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH T--ETC(U)
JUN 77 A S DAVENPORT, J B LAPOINTE N00014-76-C-0362

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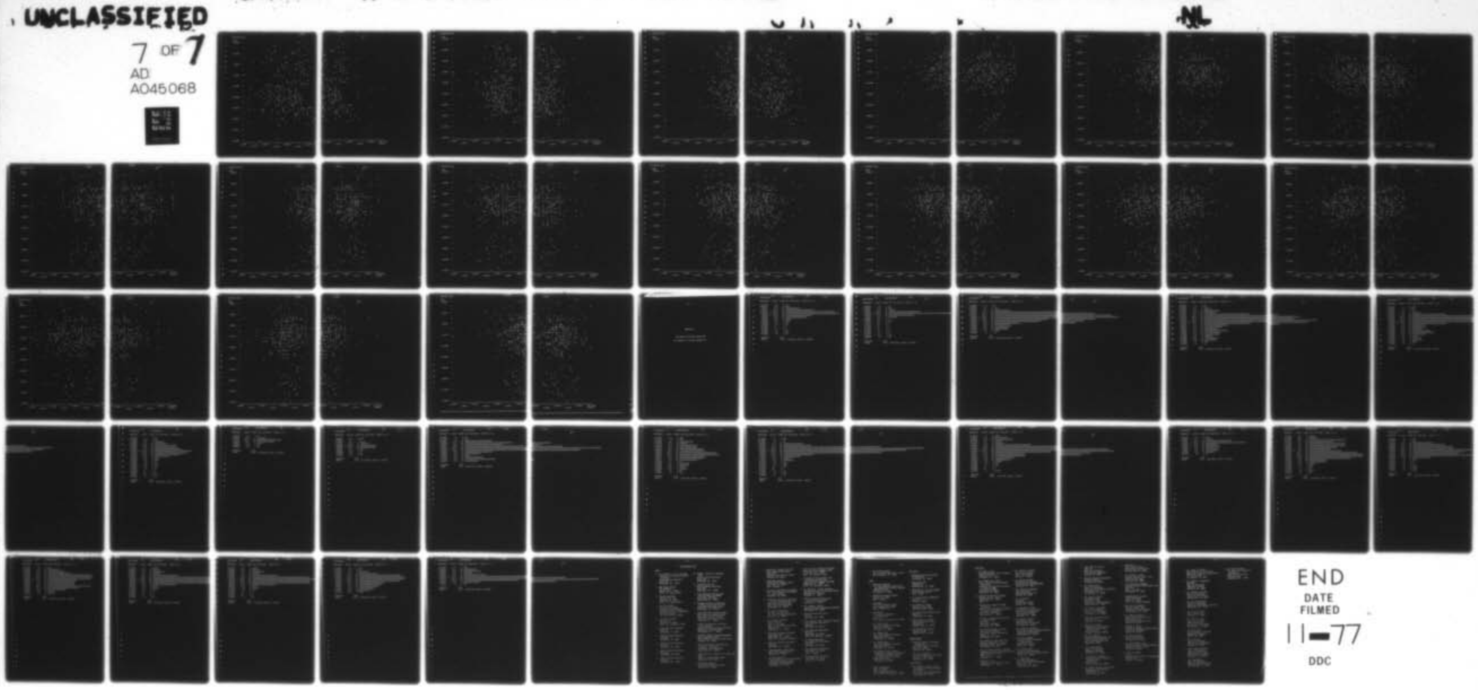

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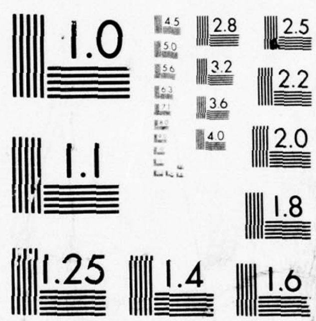

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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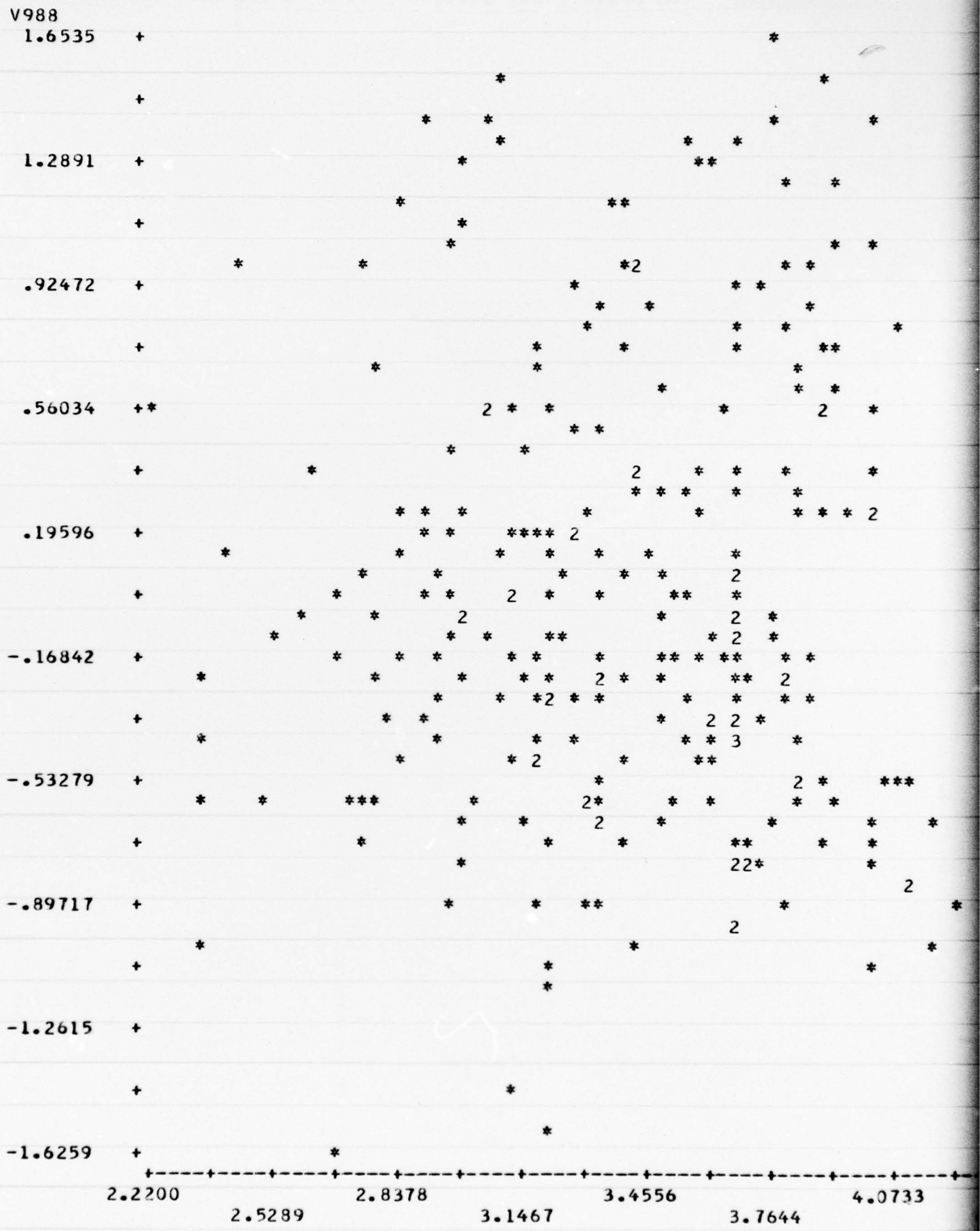
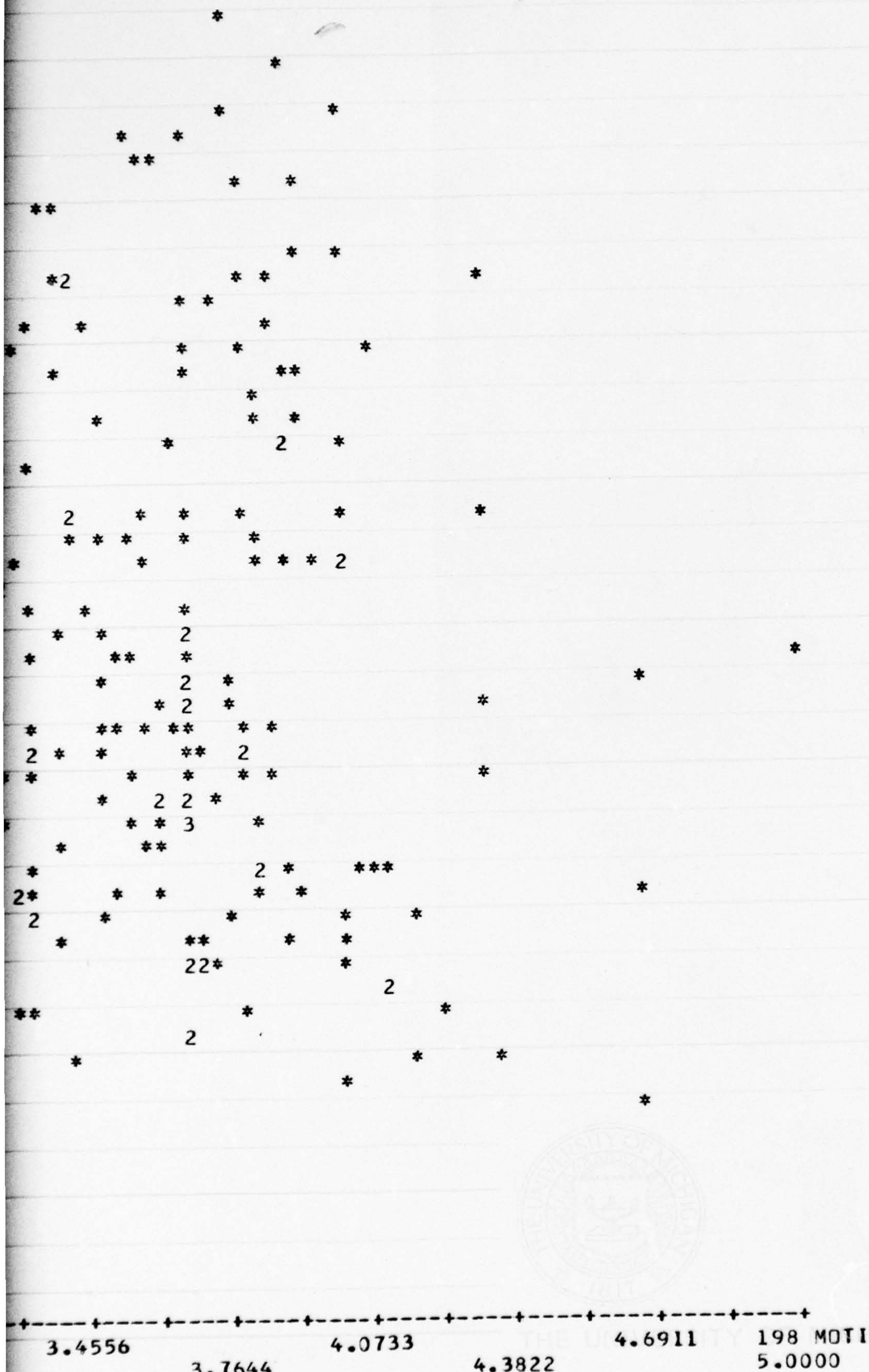
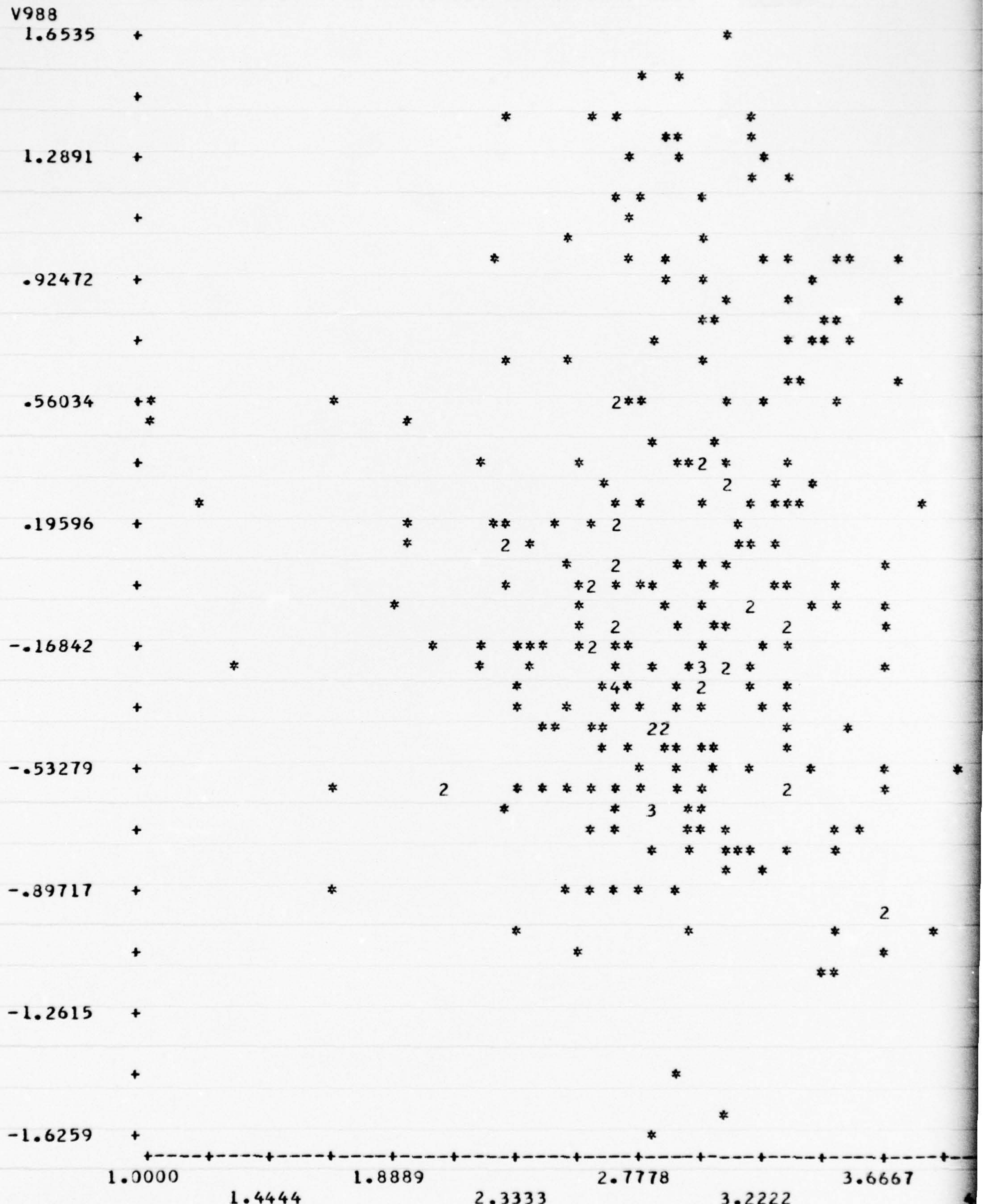


B-234

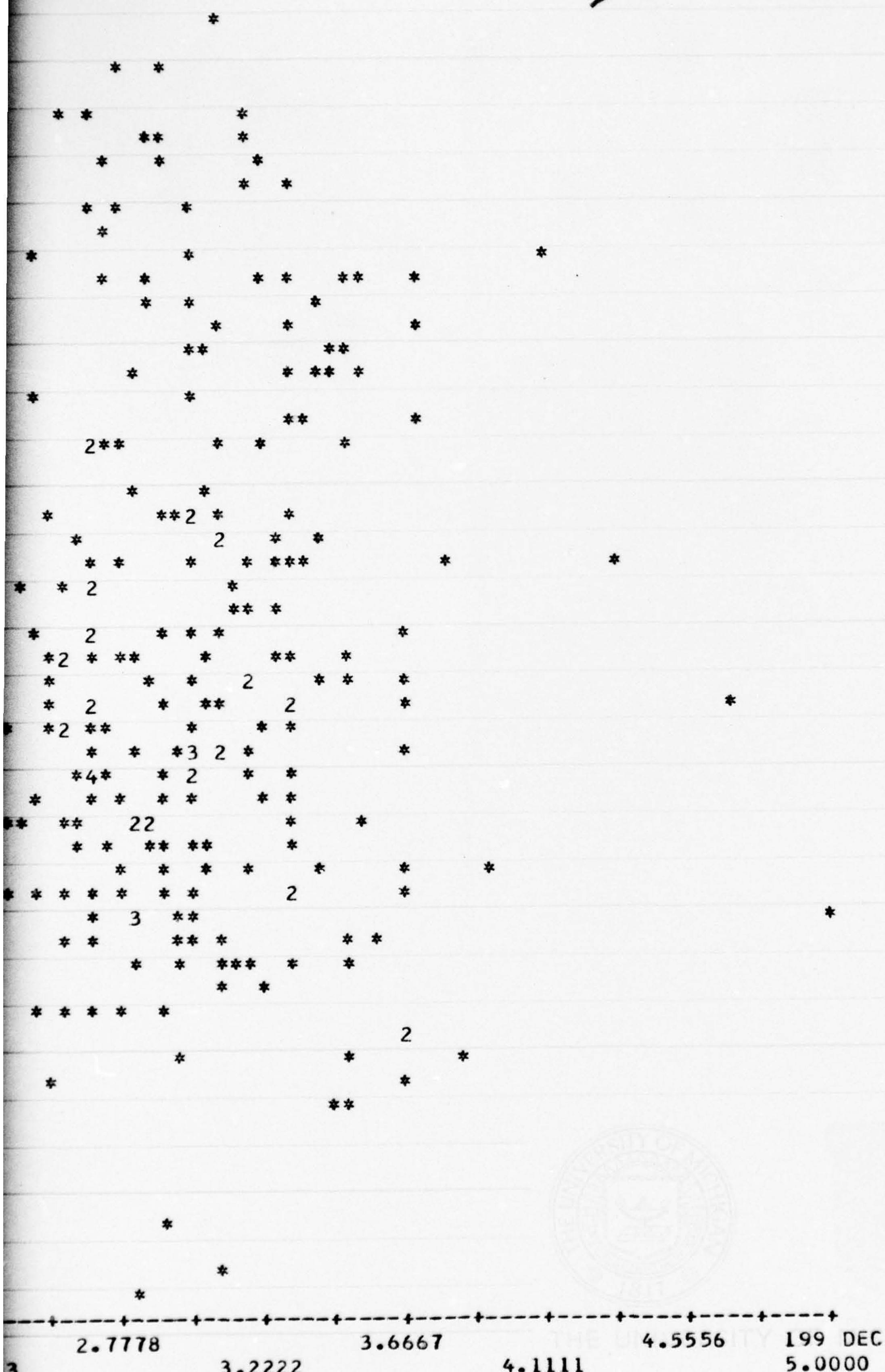
2



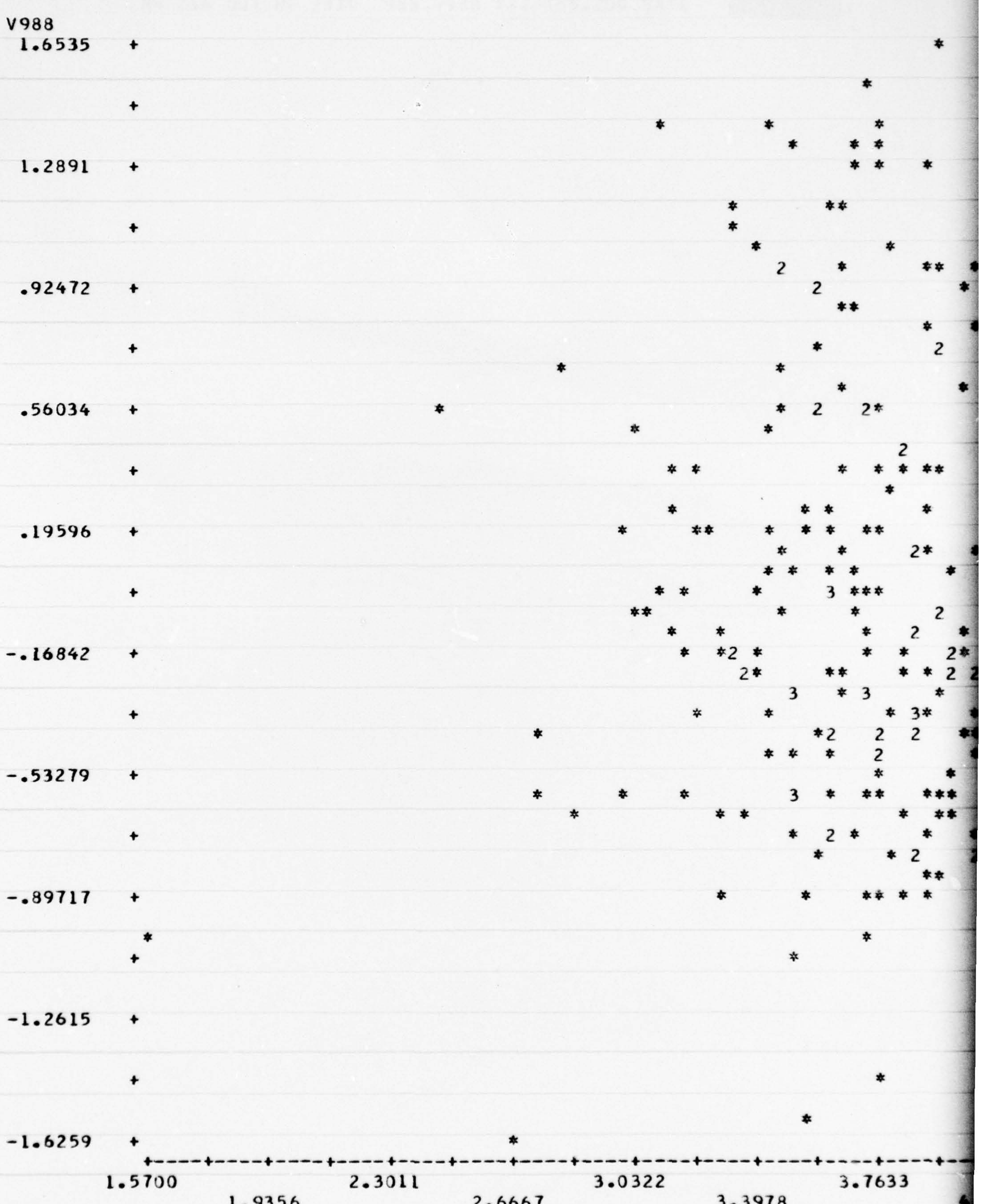
SCATTER PLOT



2



SCATTER PLOT



B-236

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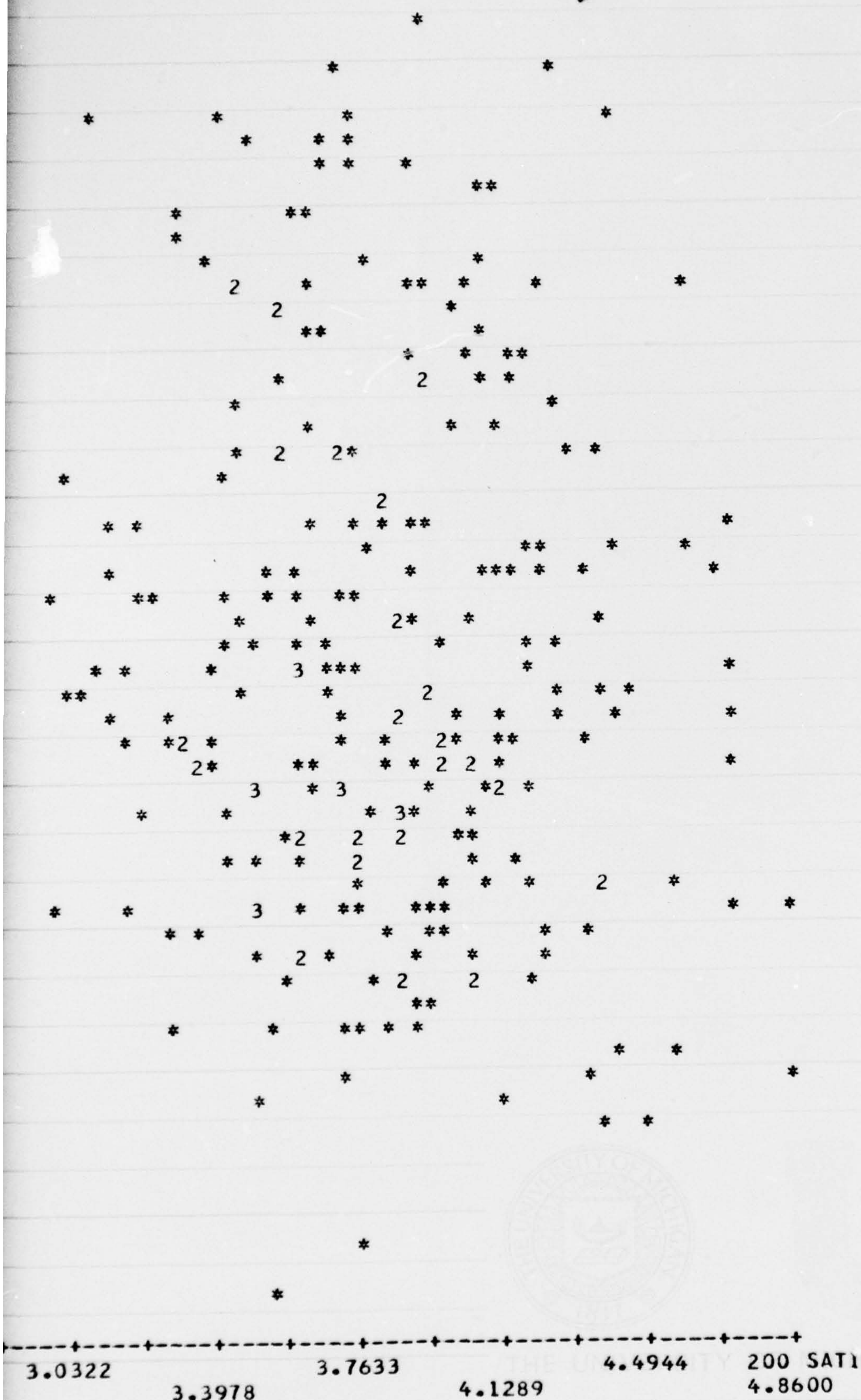
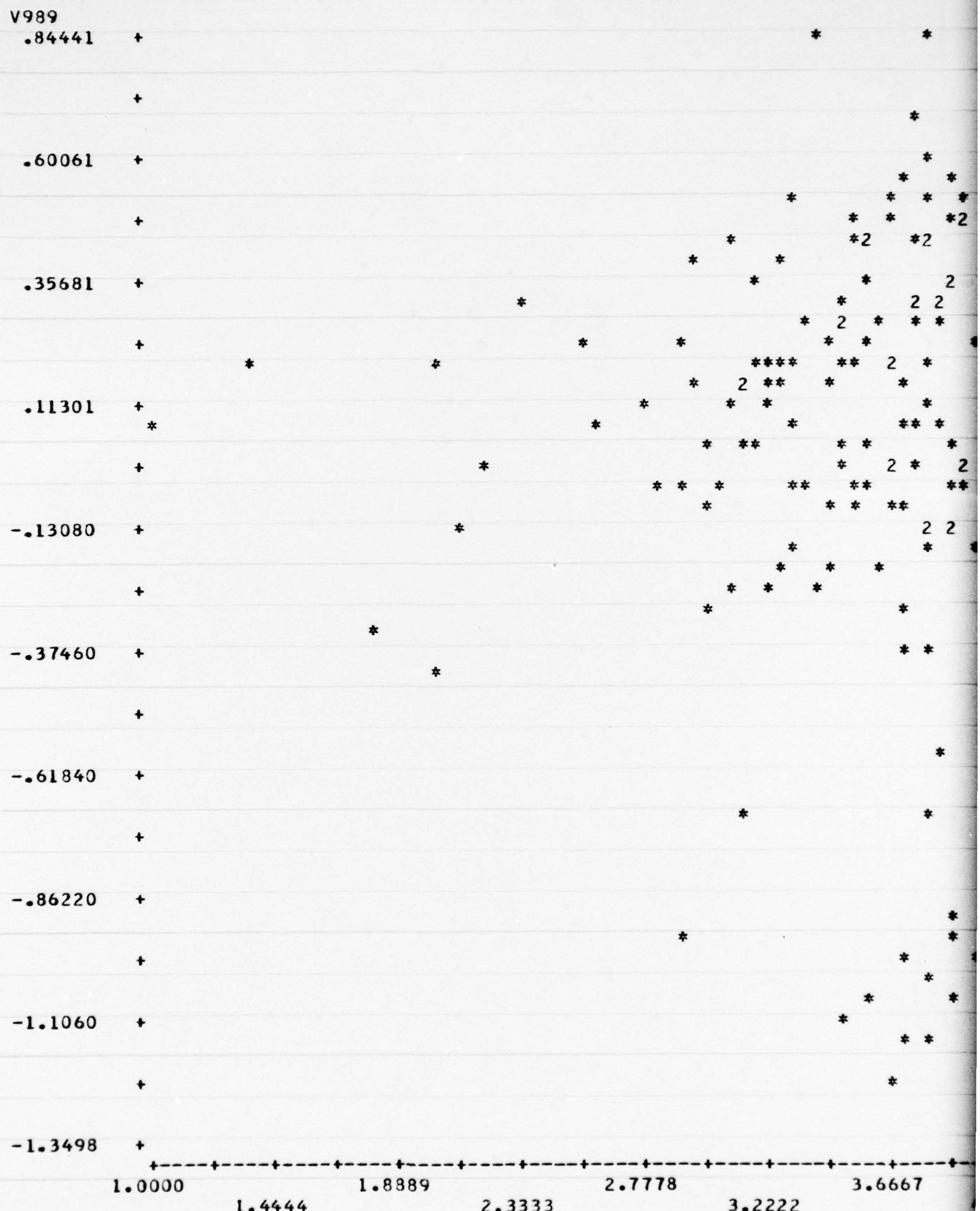
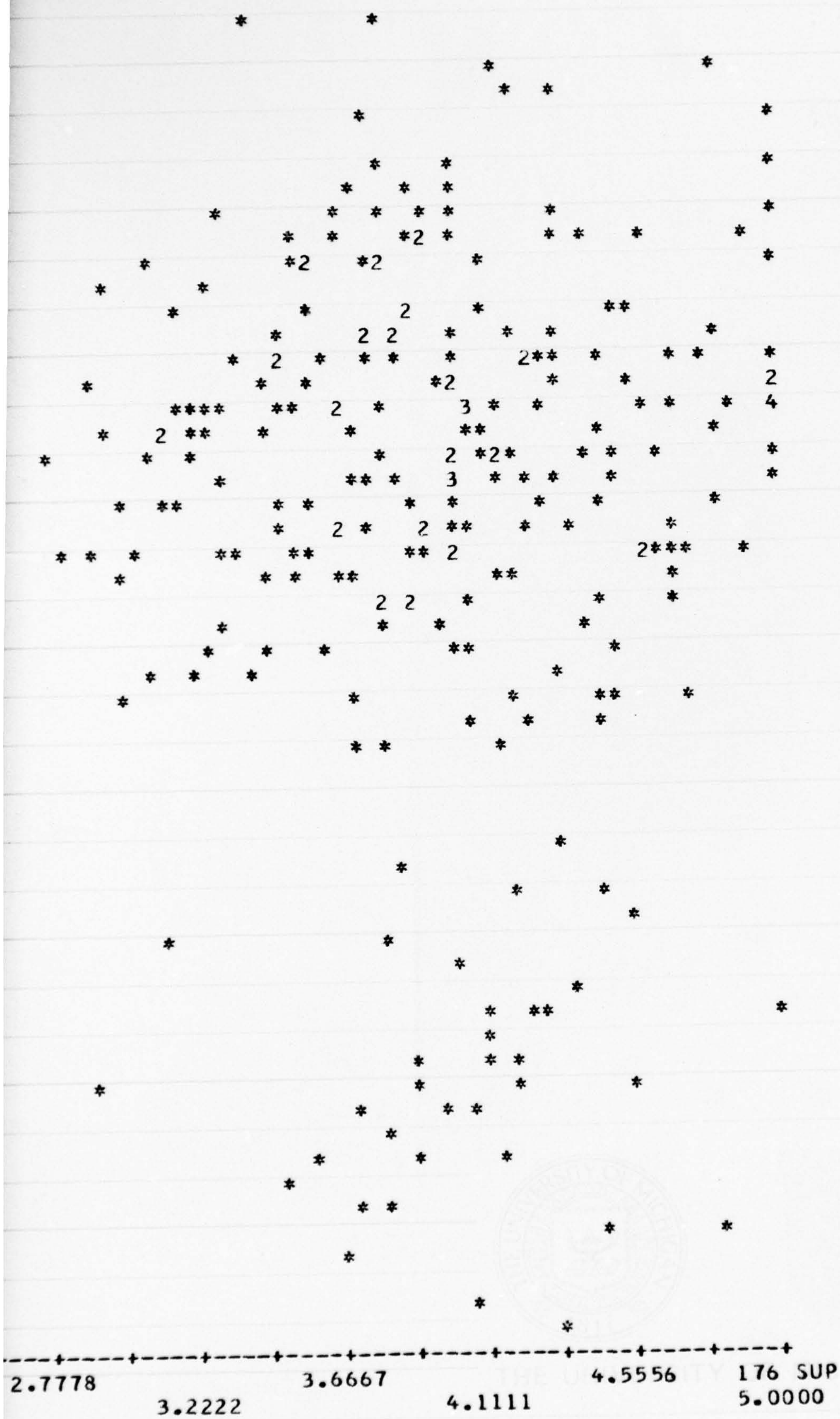


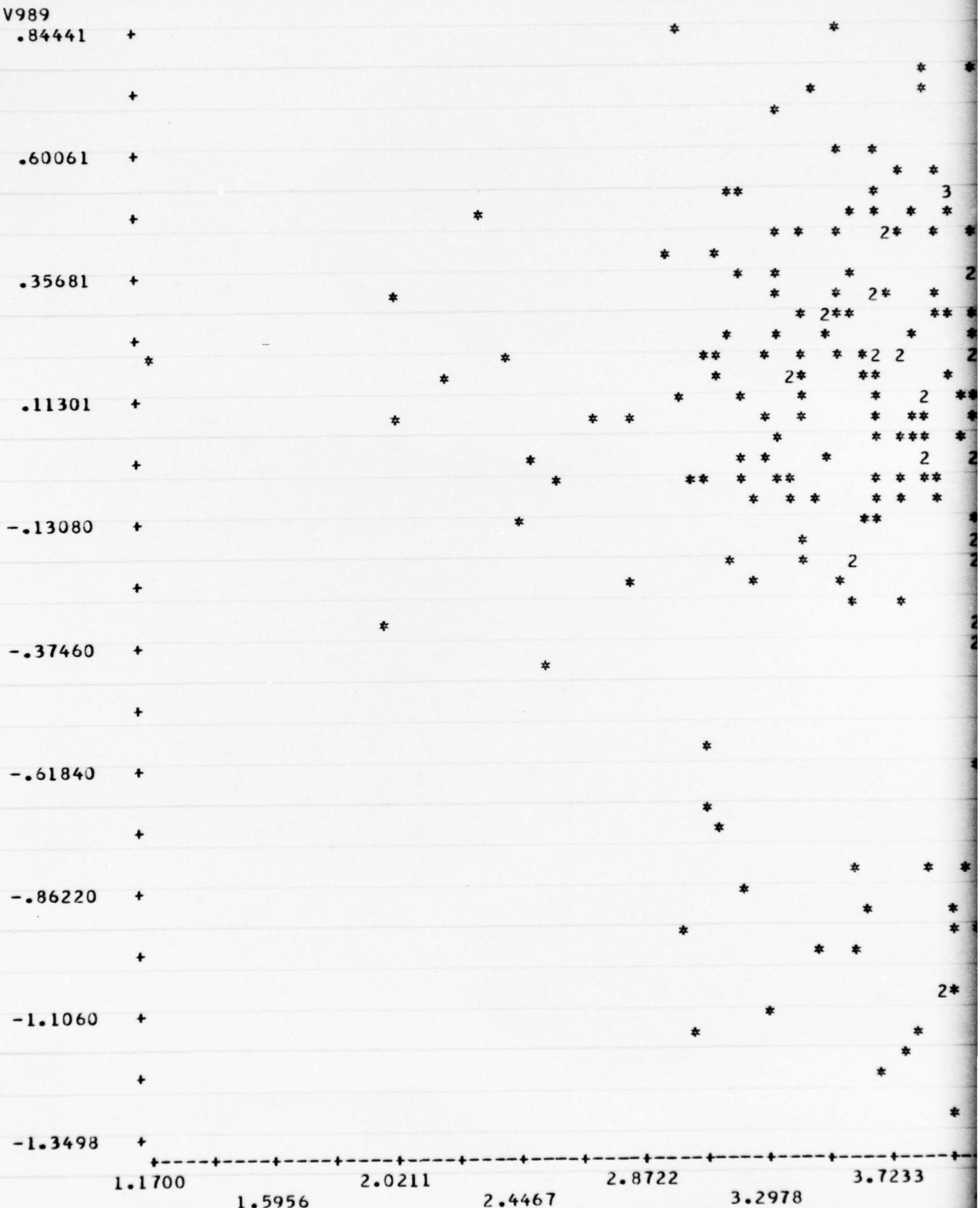
SCATTER PLOT



B-237

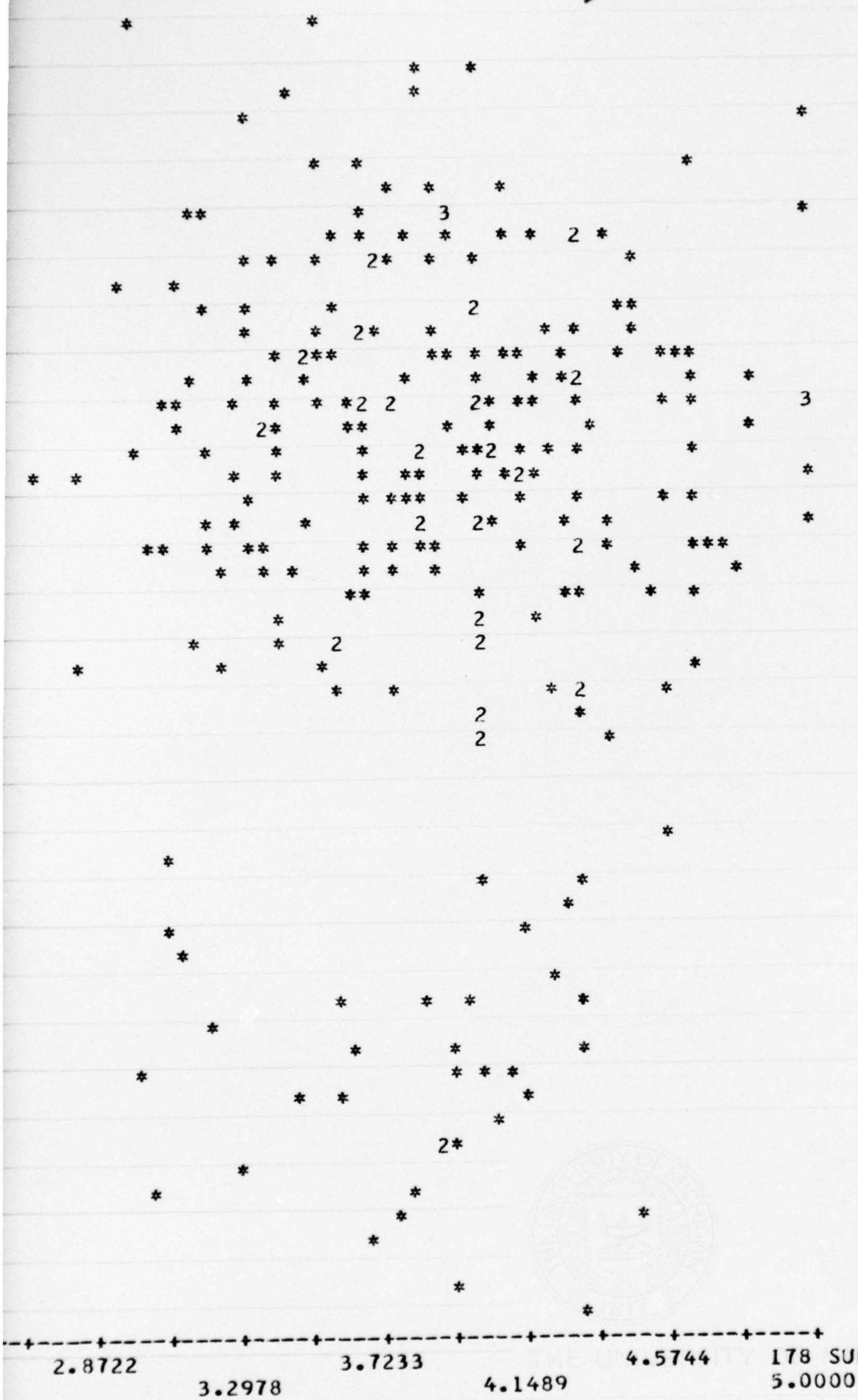


SCATTER PLOT

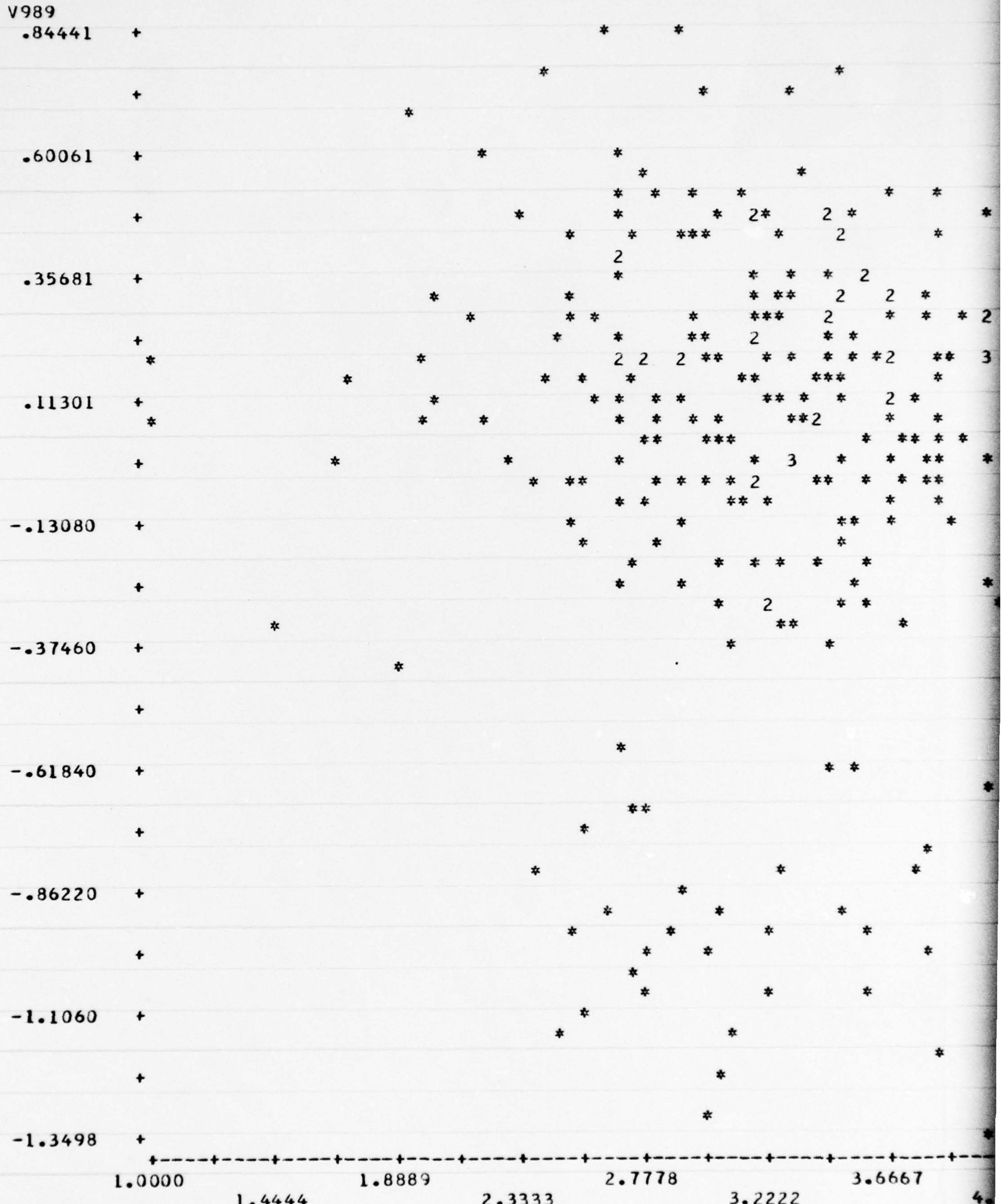


B-238

2



SCATTER PLOT



B-239

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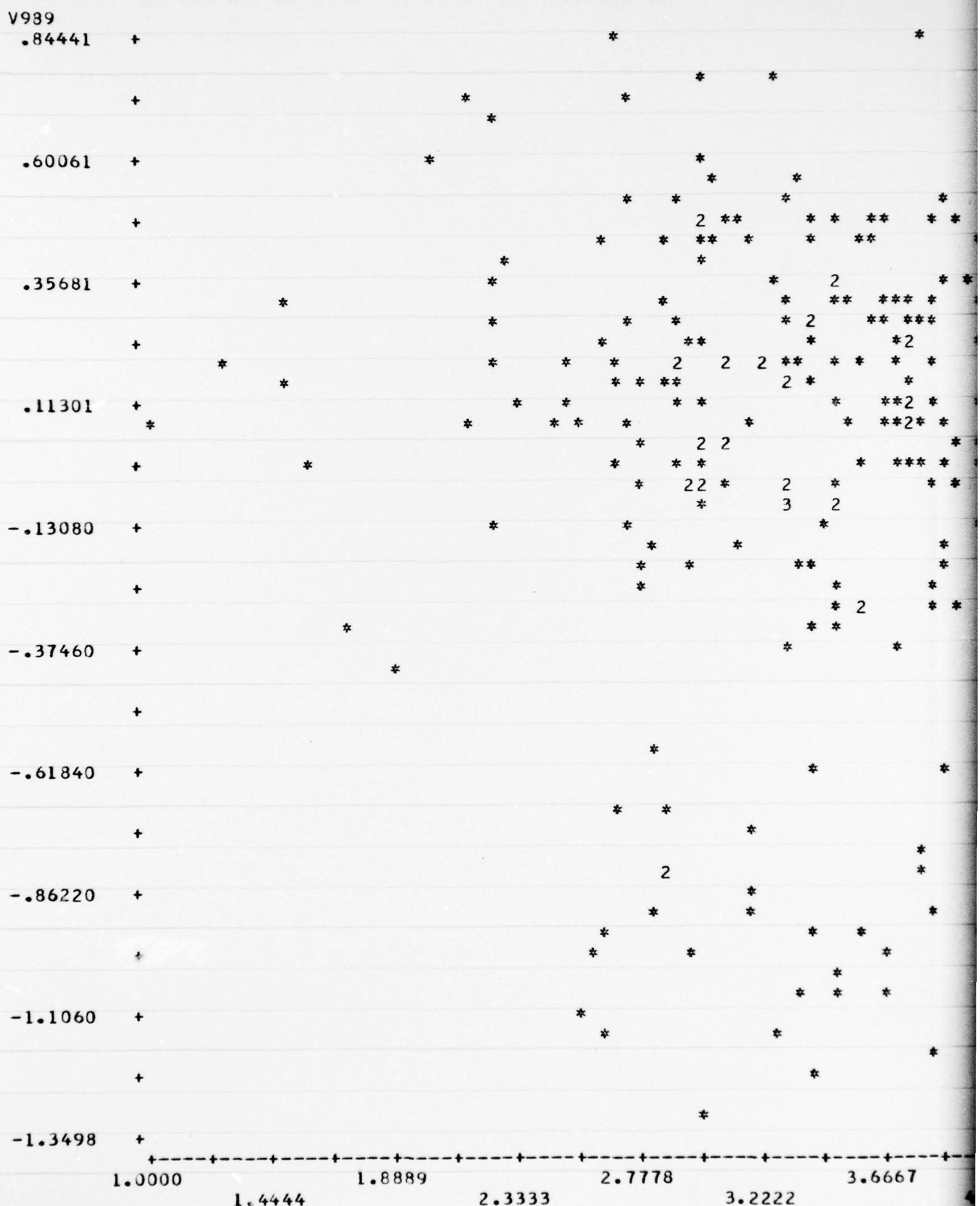
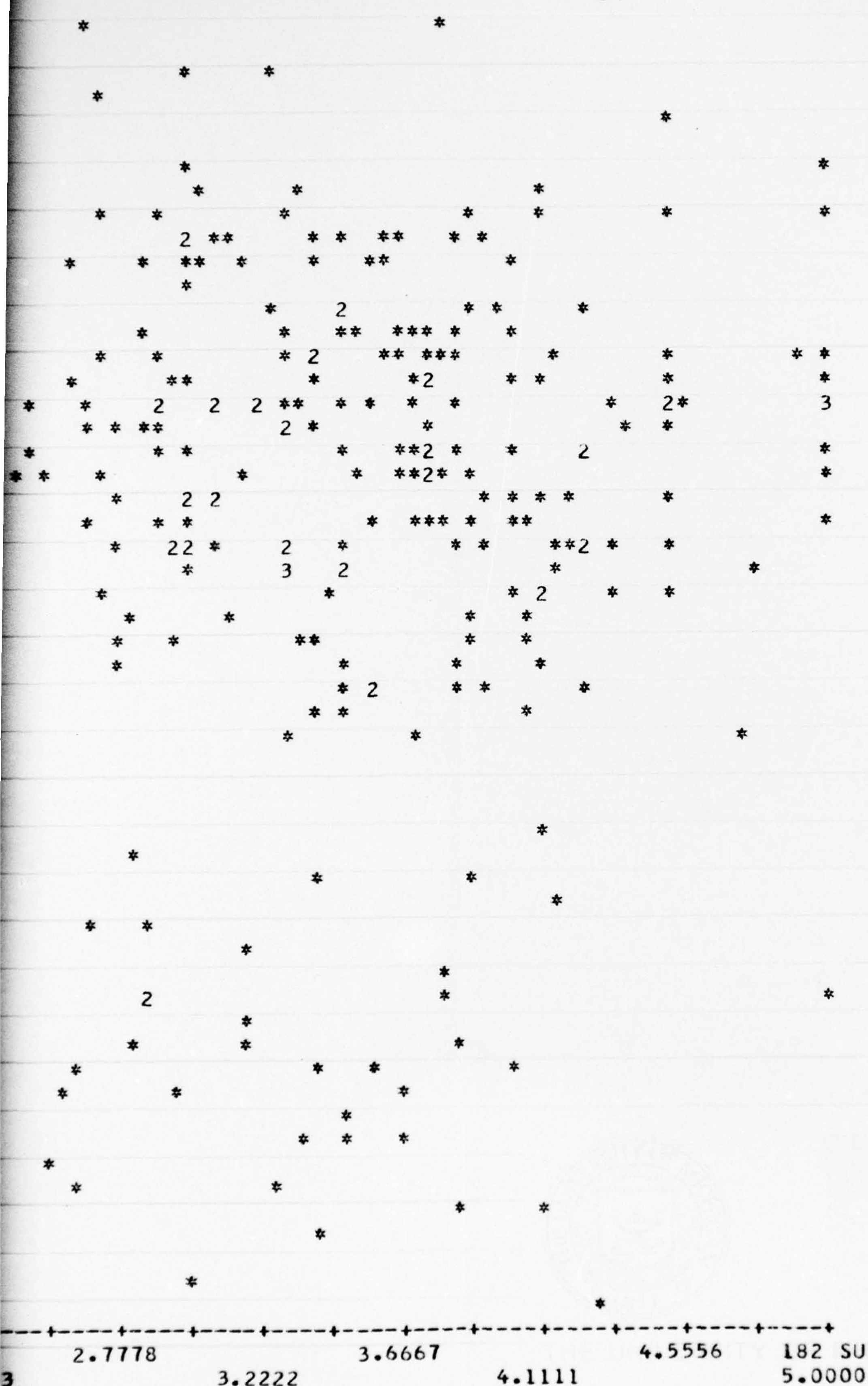
SCATTER PLOT

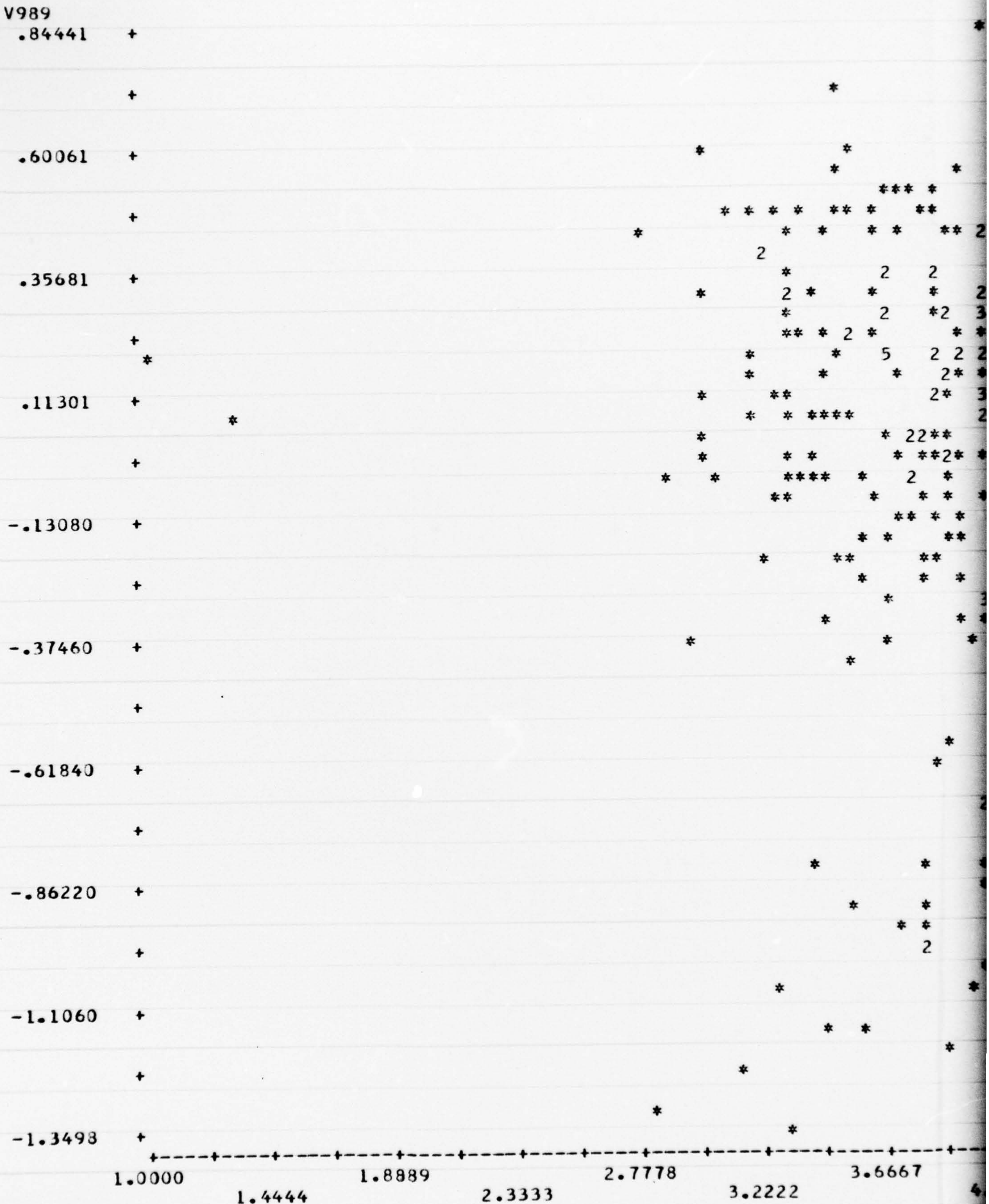


B-240

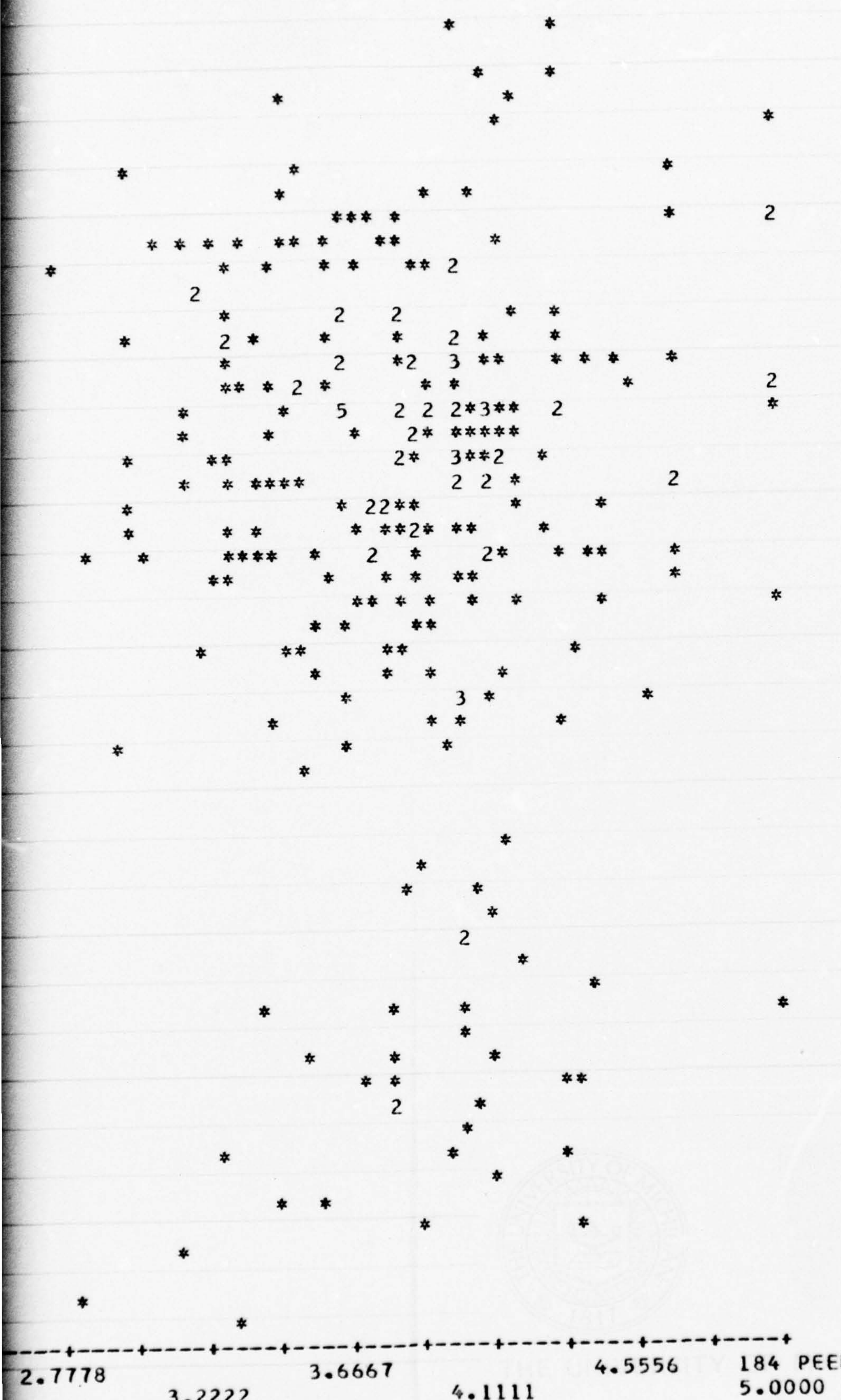
2



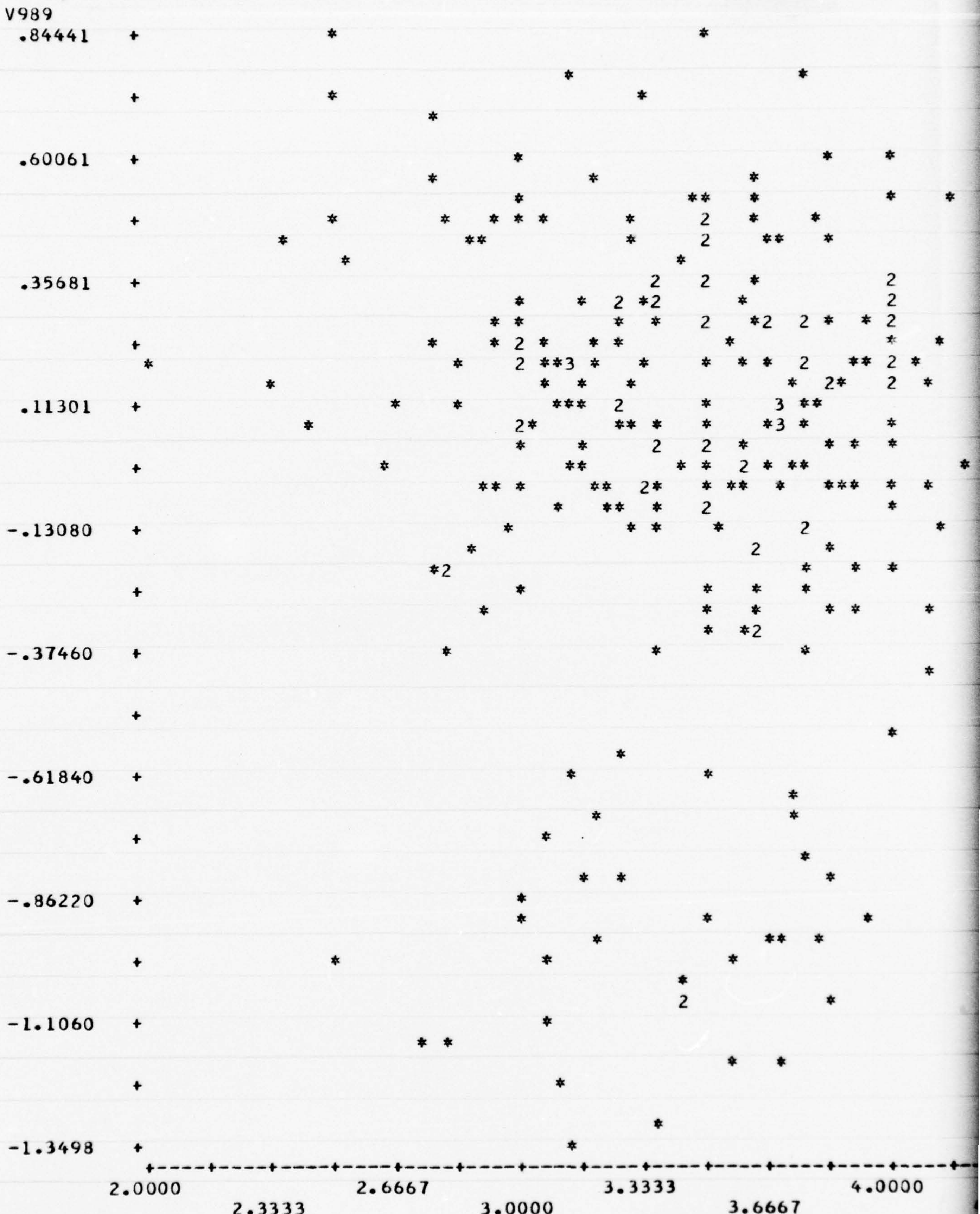
SCATTER PLOT



2

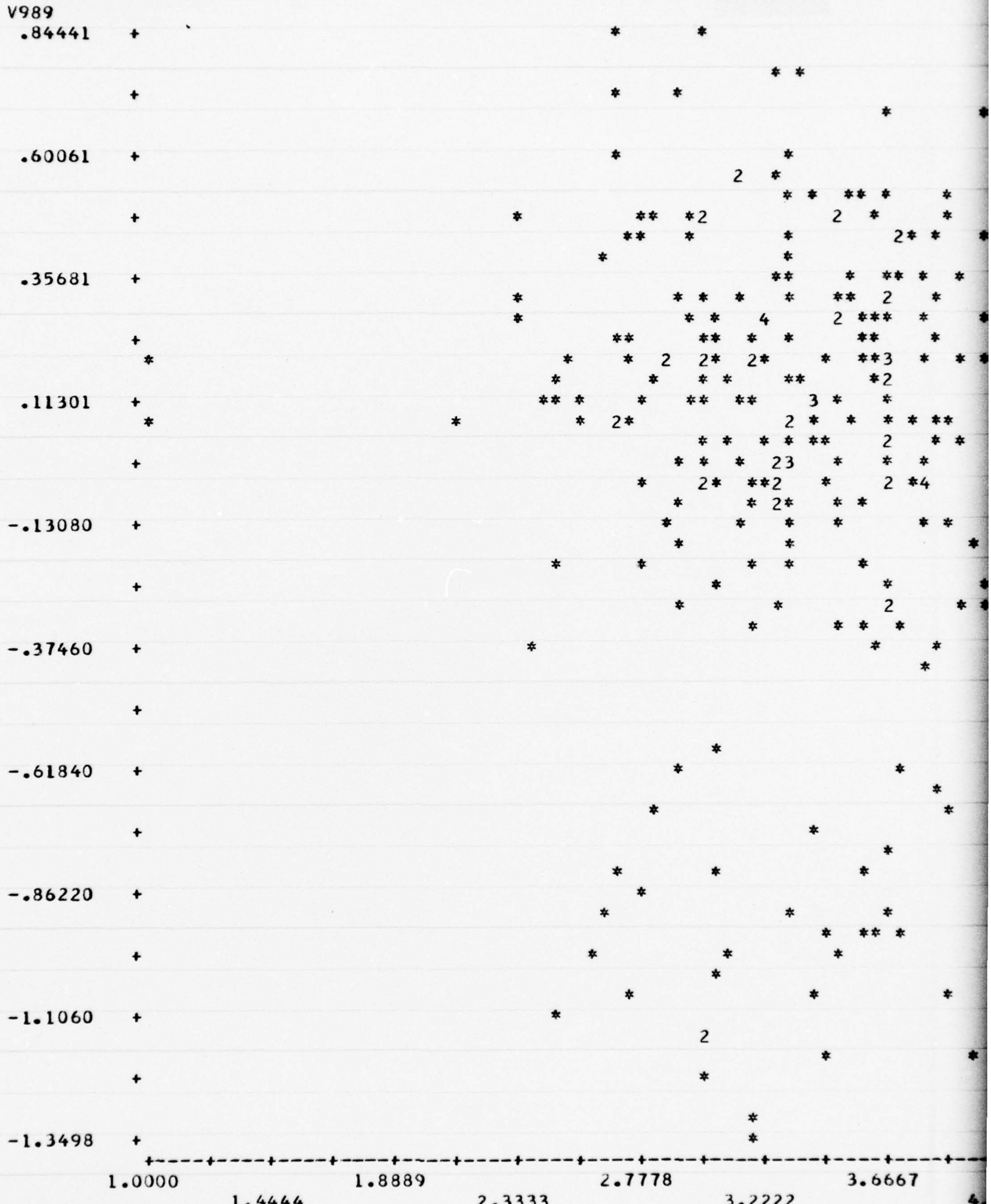


SCATTER PLOT



2

SCATTER PLOT



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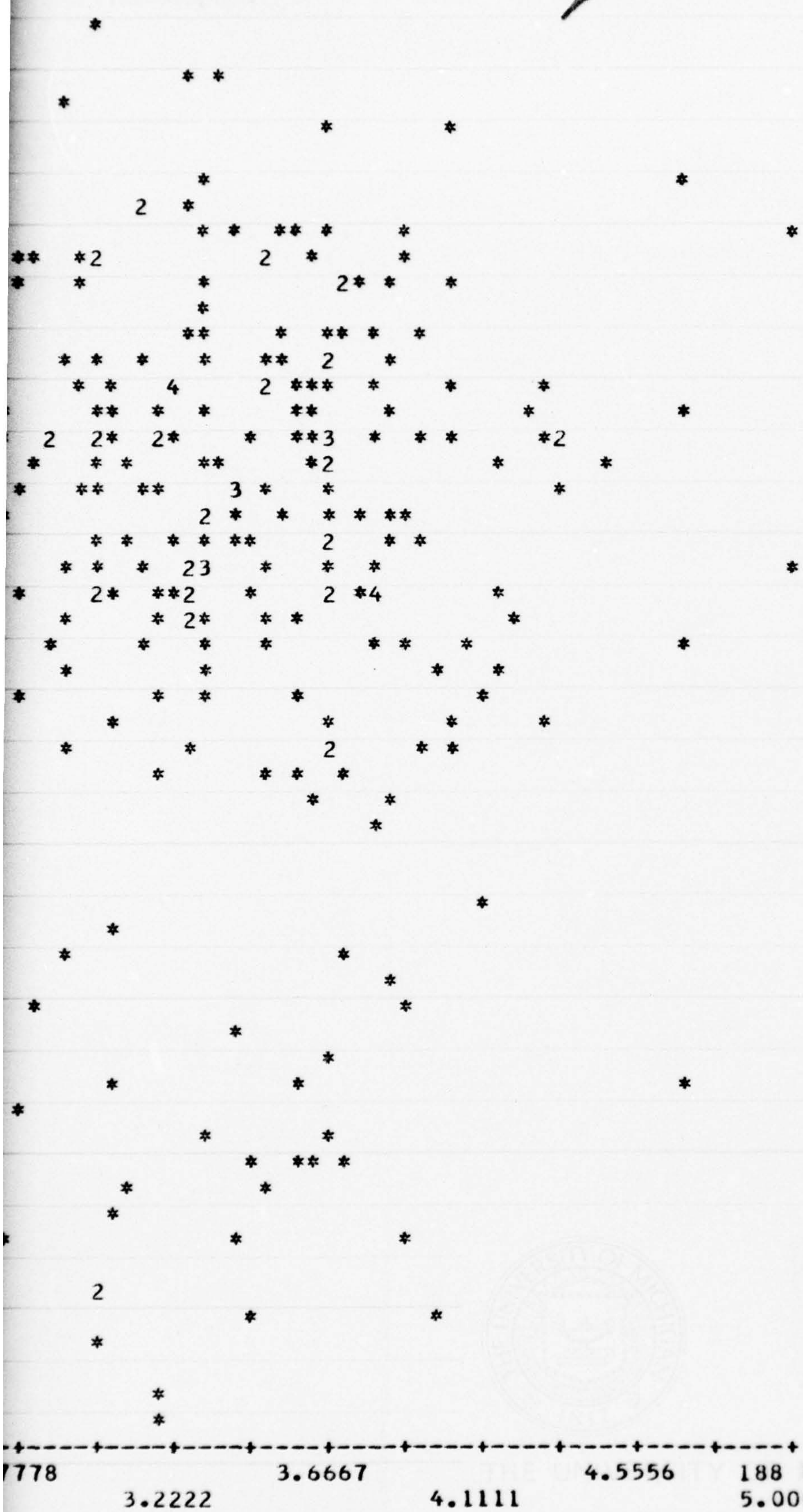
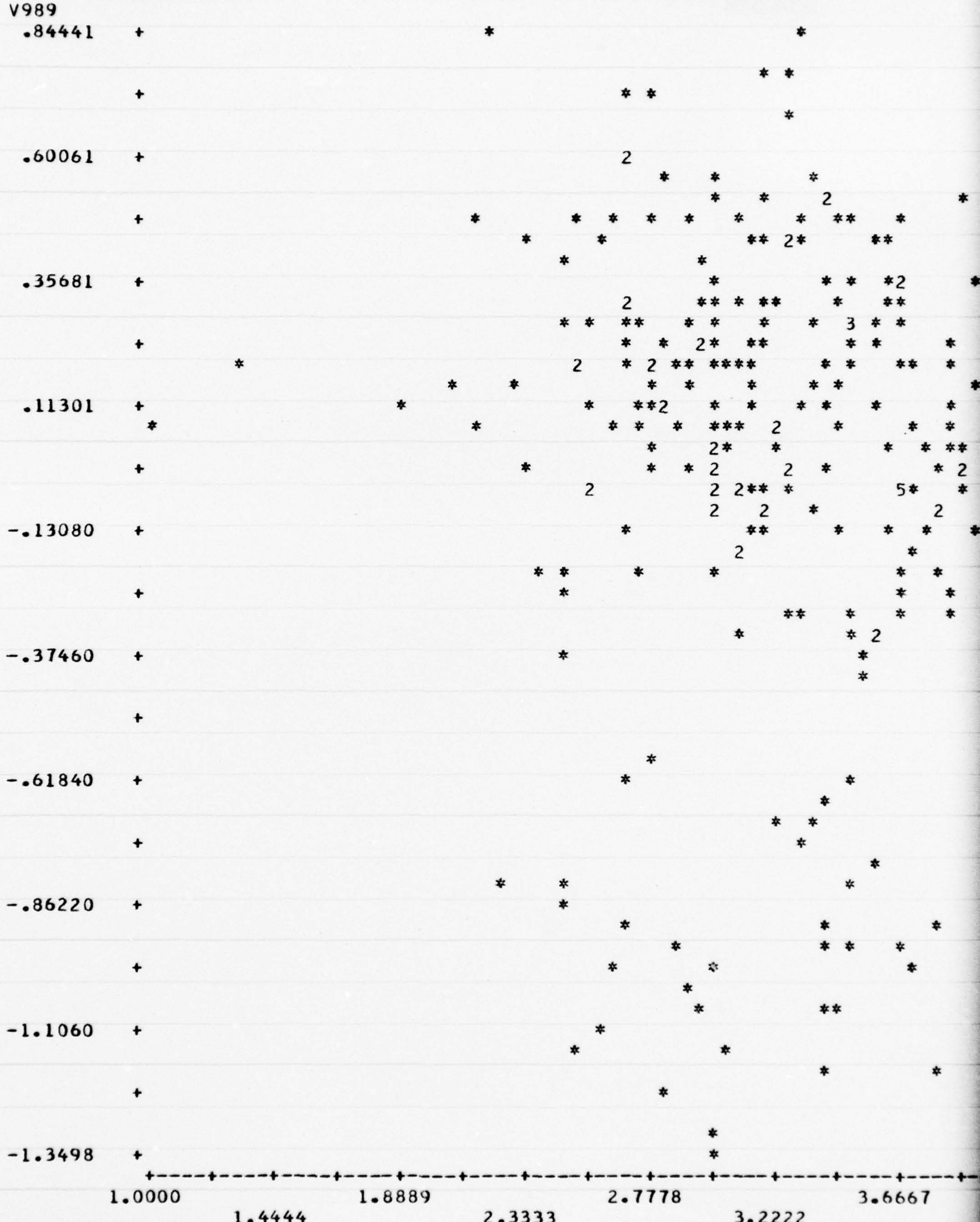
2

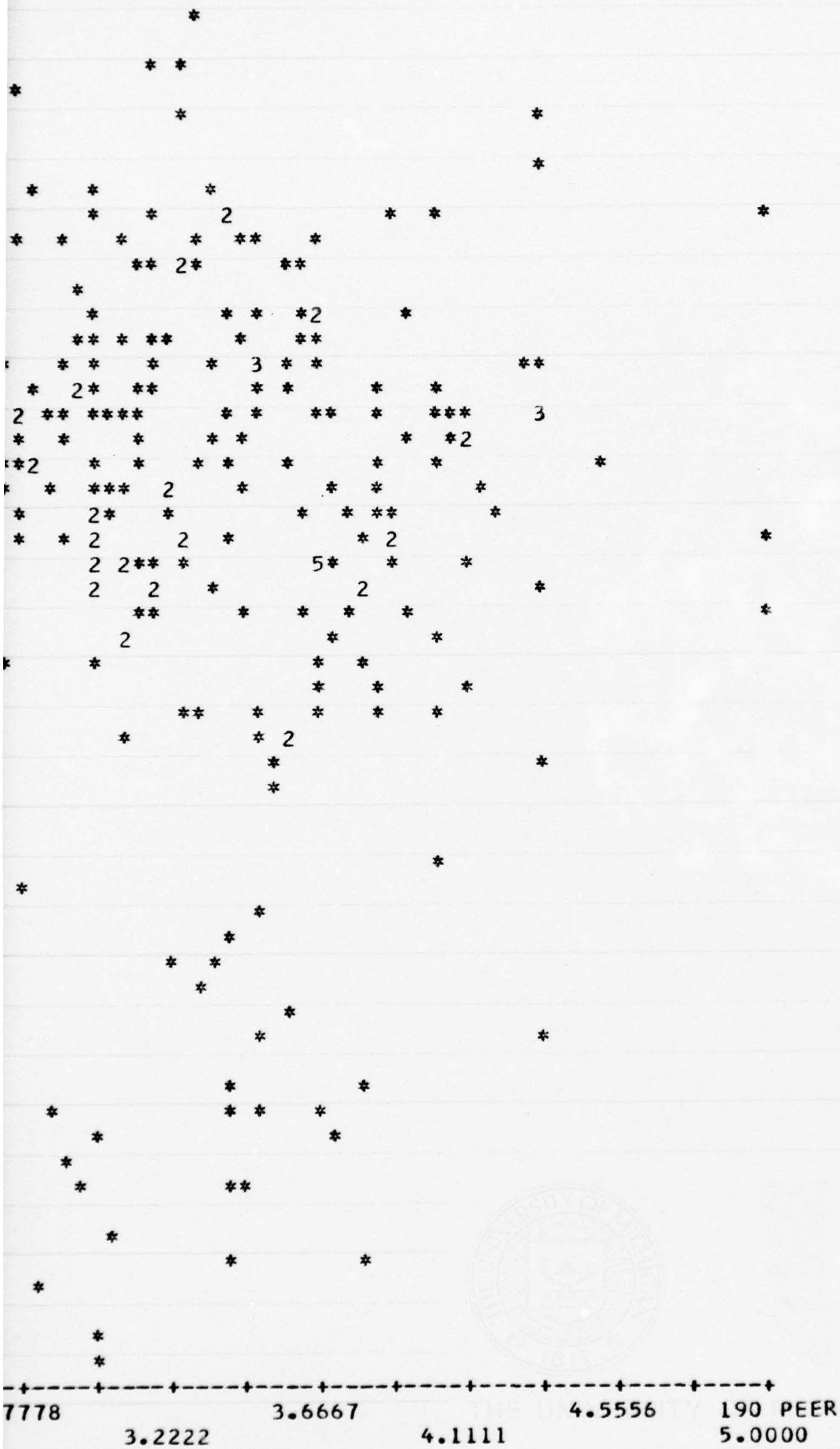


SCATTER PLOT

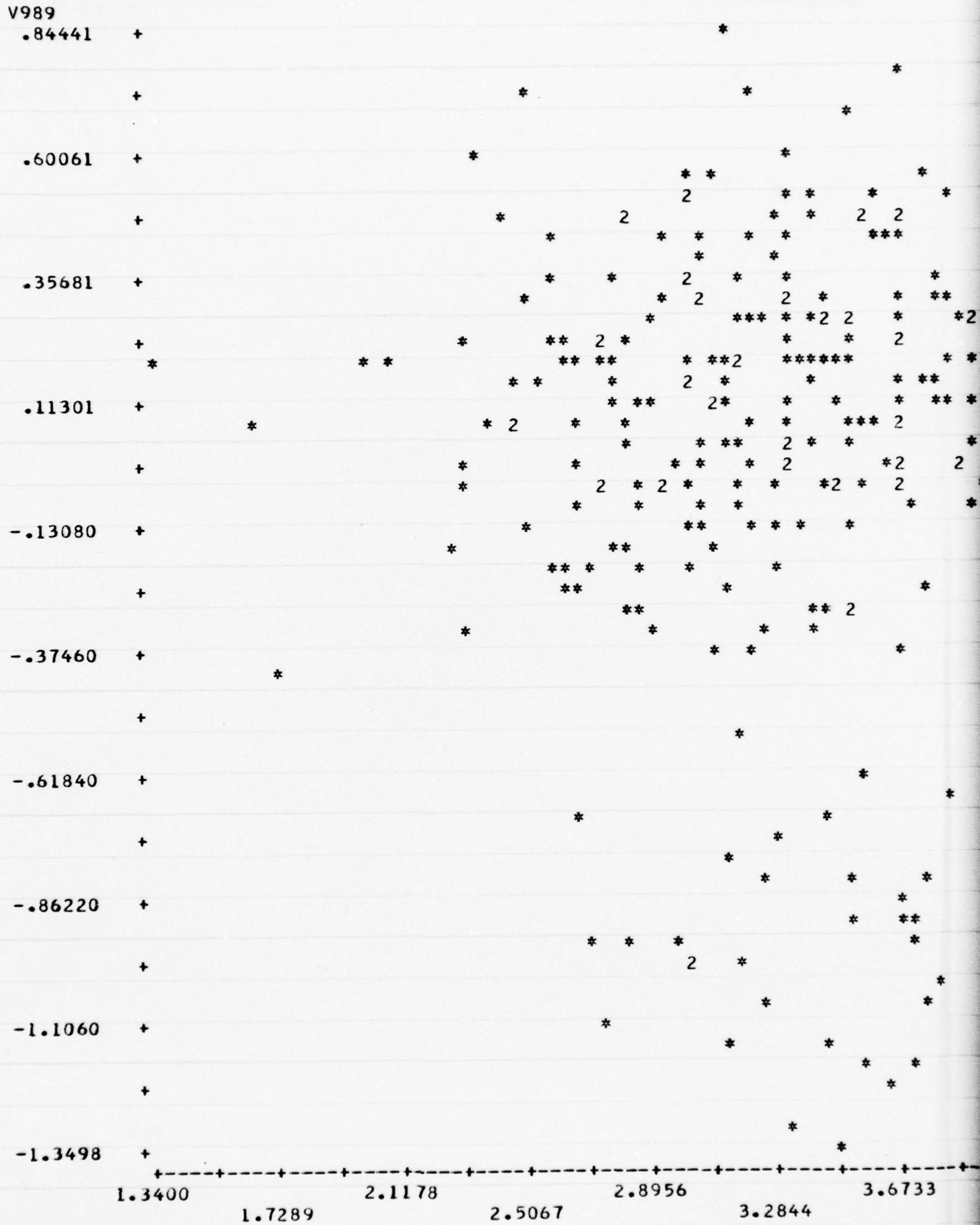


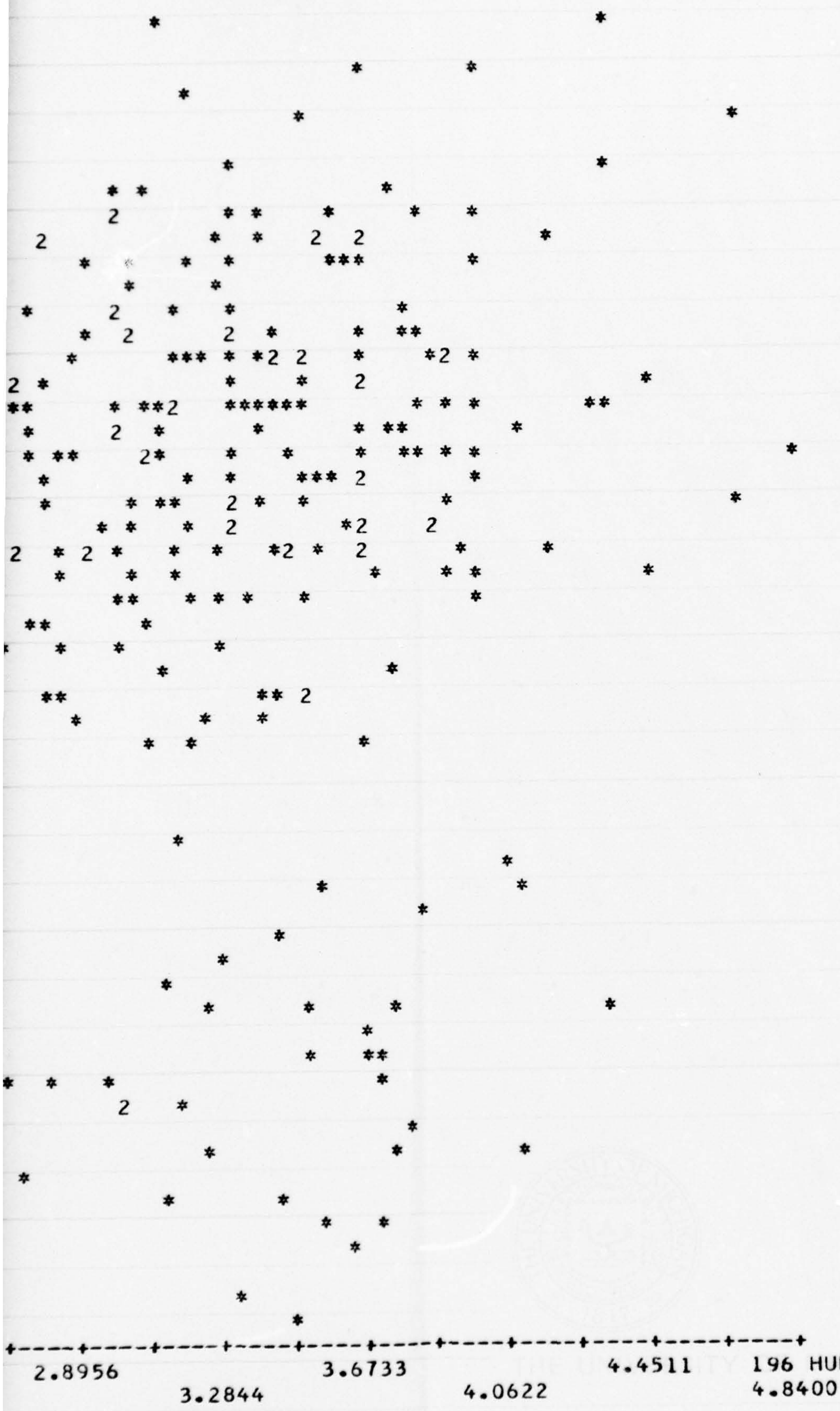
B-244

2

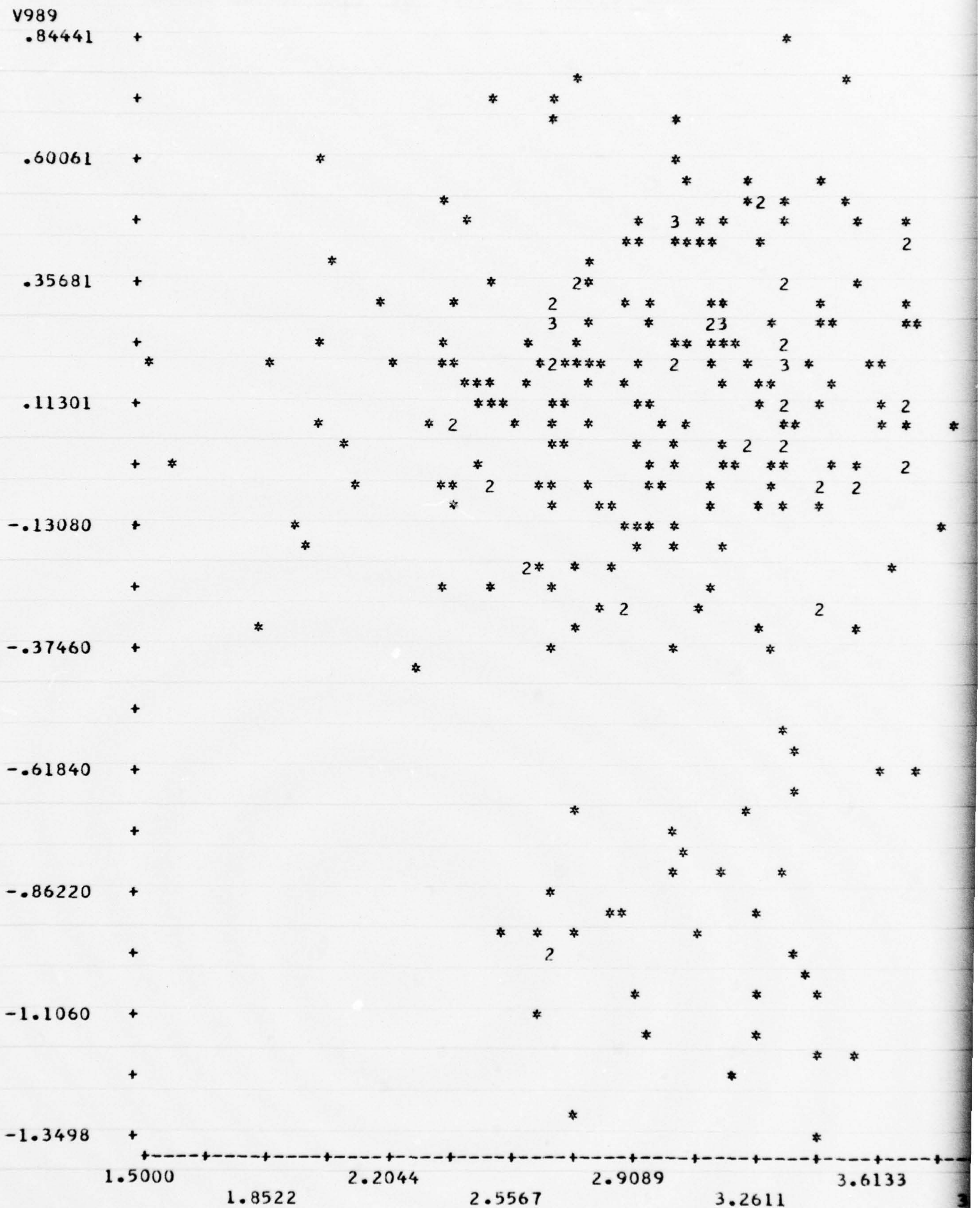


SCATTER PLOT




2.8956
3.2844
3.6733
4.0622
4.4511
196 HUM.
4.8400

SCATTER PLOT



B-246

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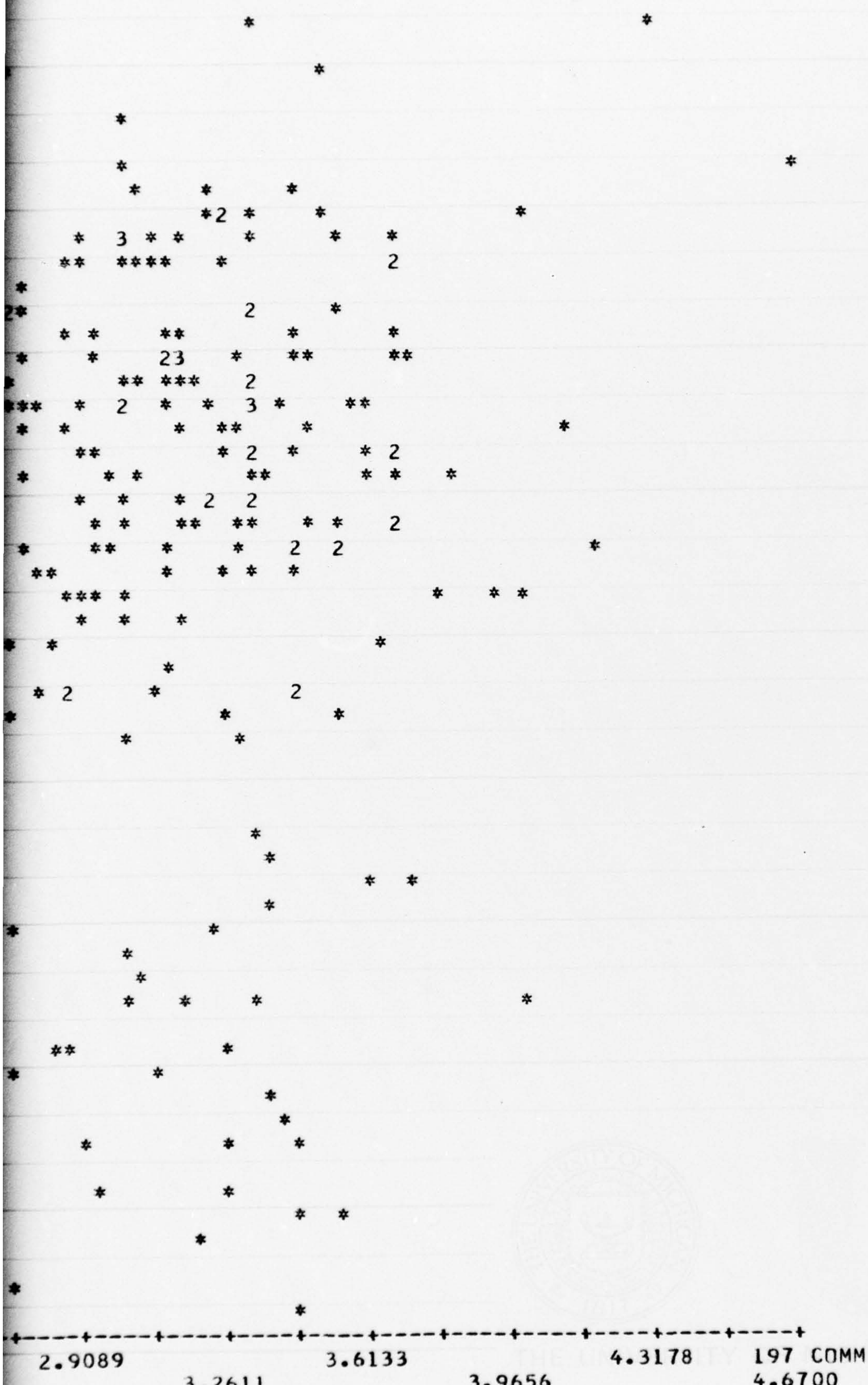
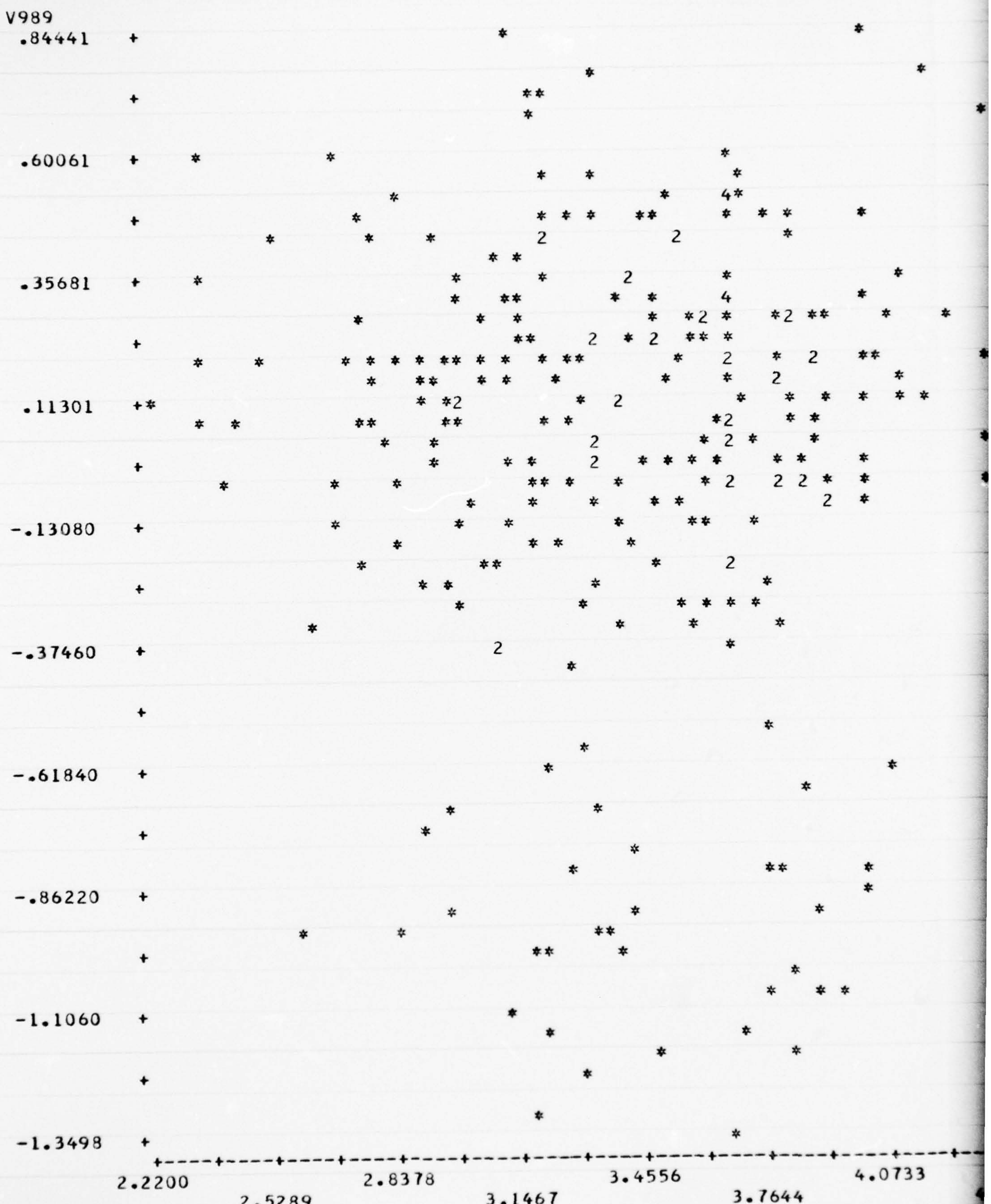
2

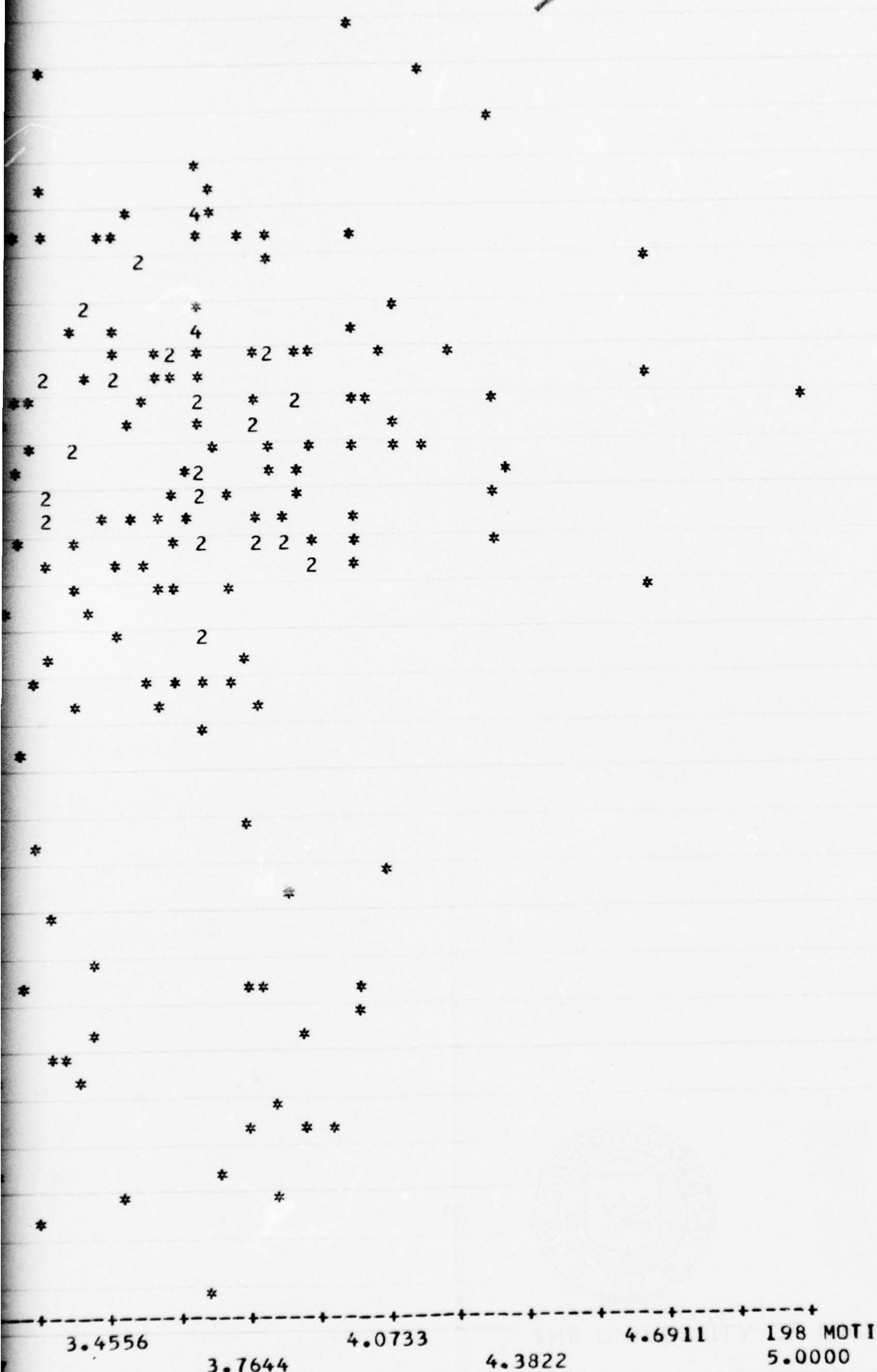


SCATTER PLOT

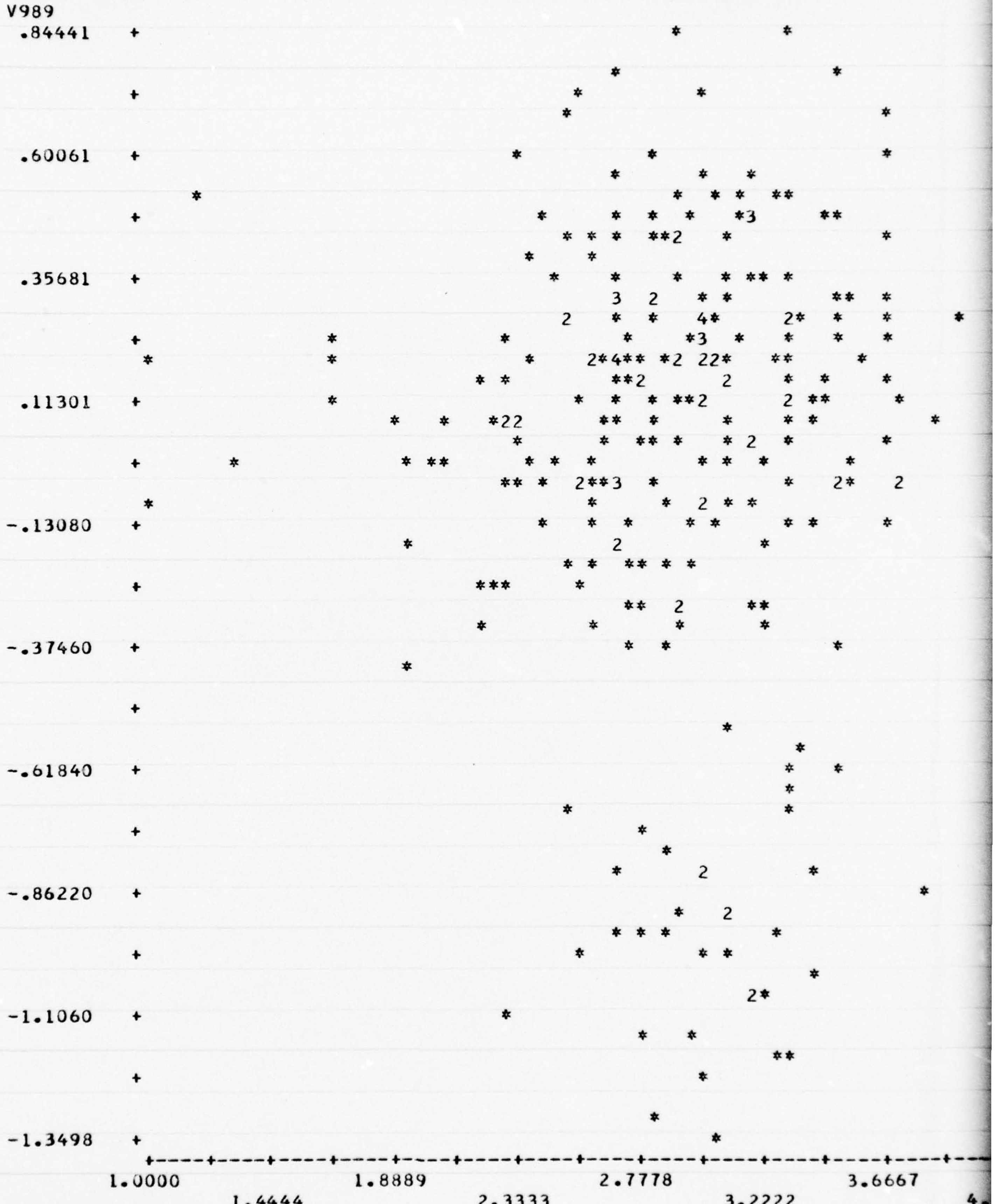


B-247

2

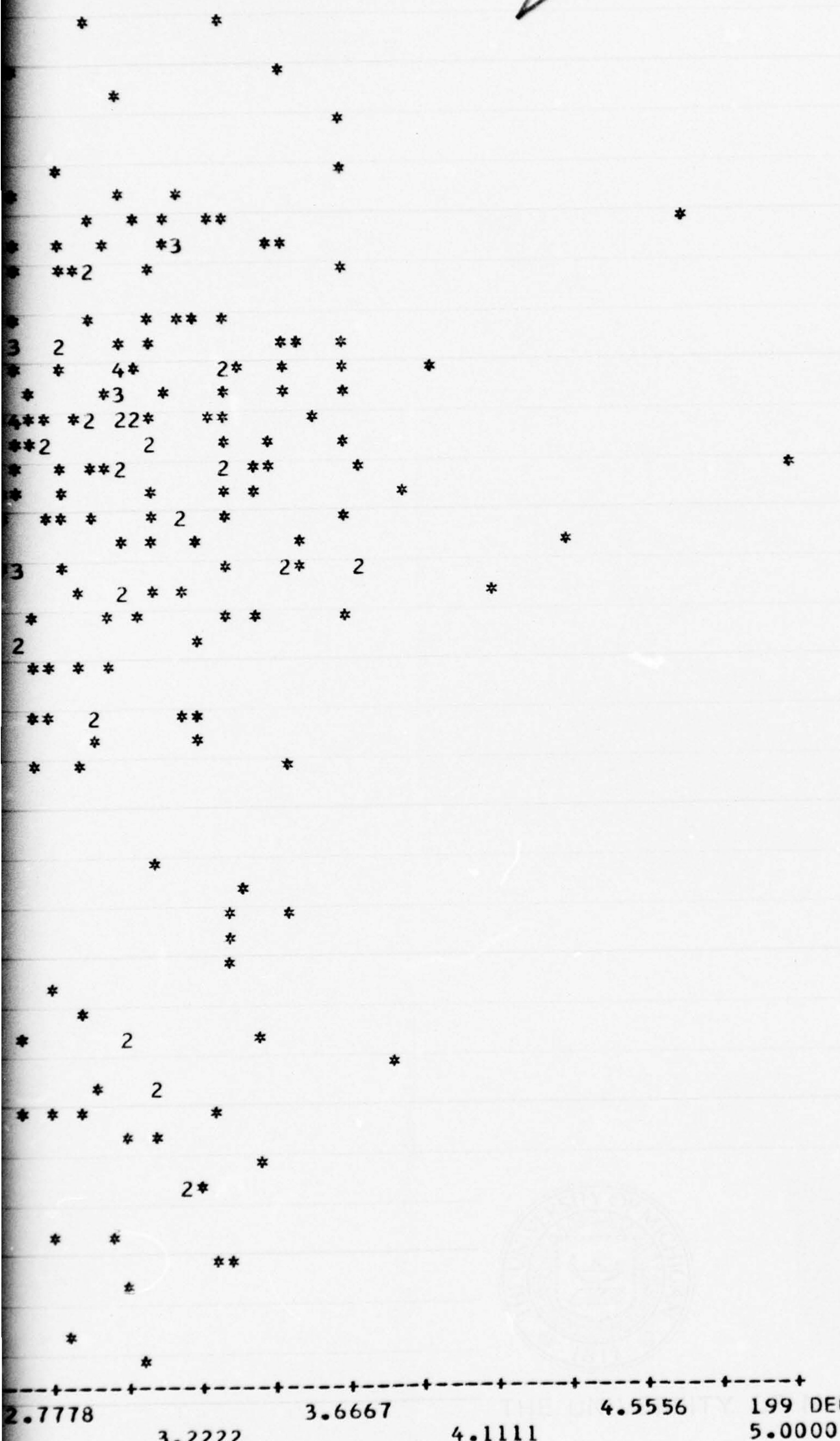


SCATTER PLOT

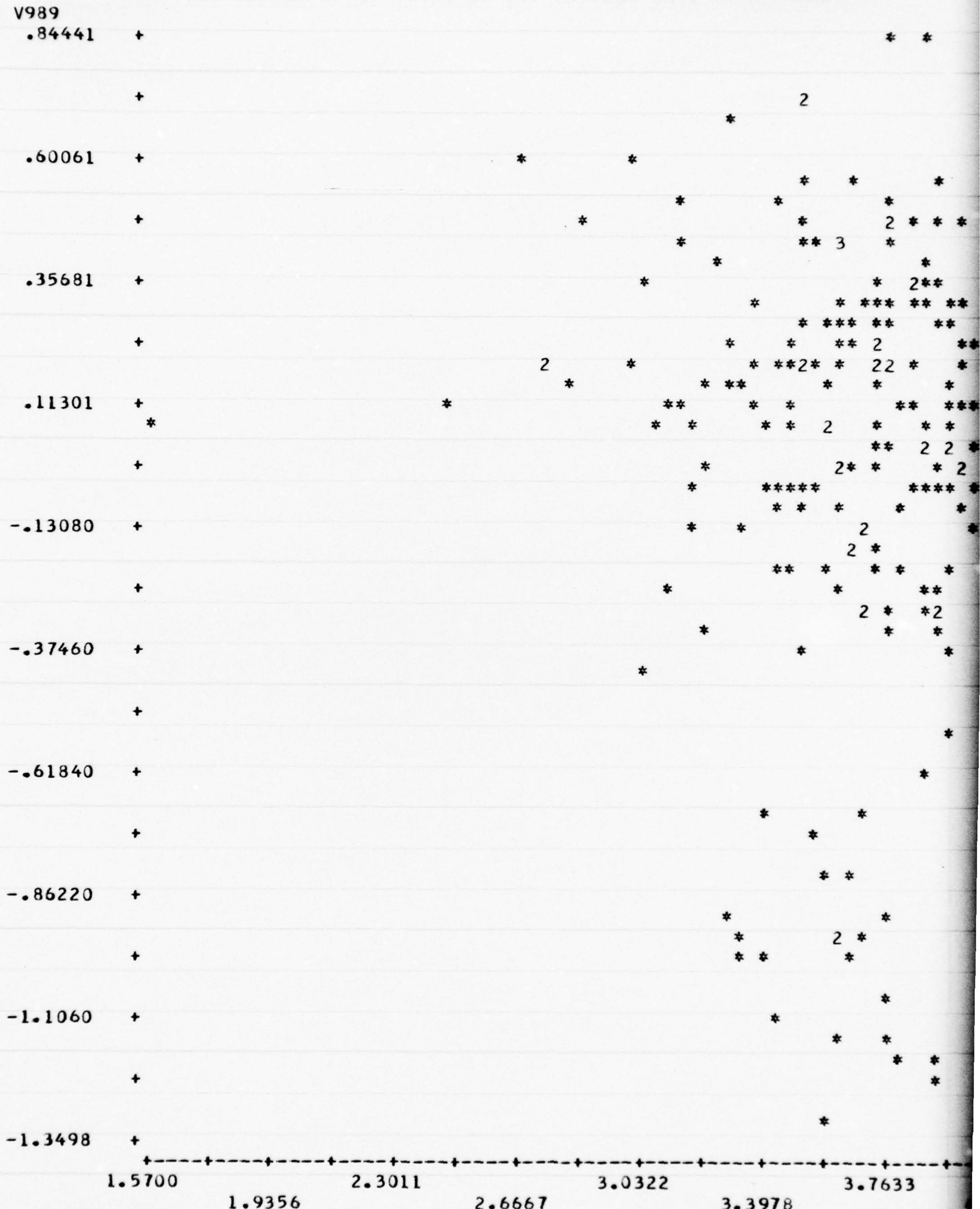


B-248

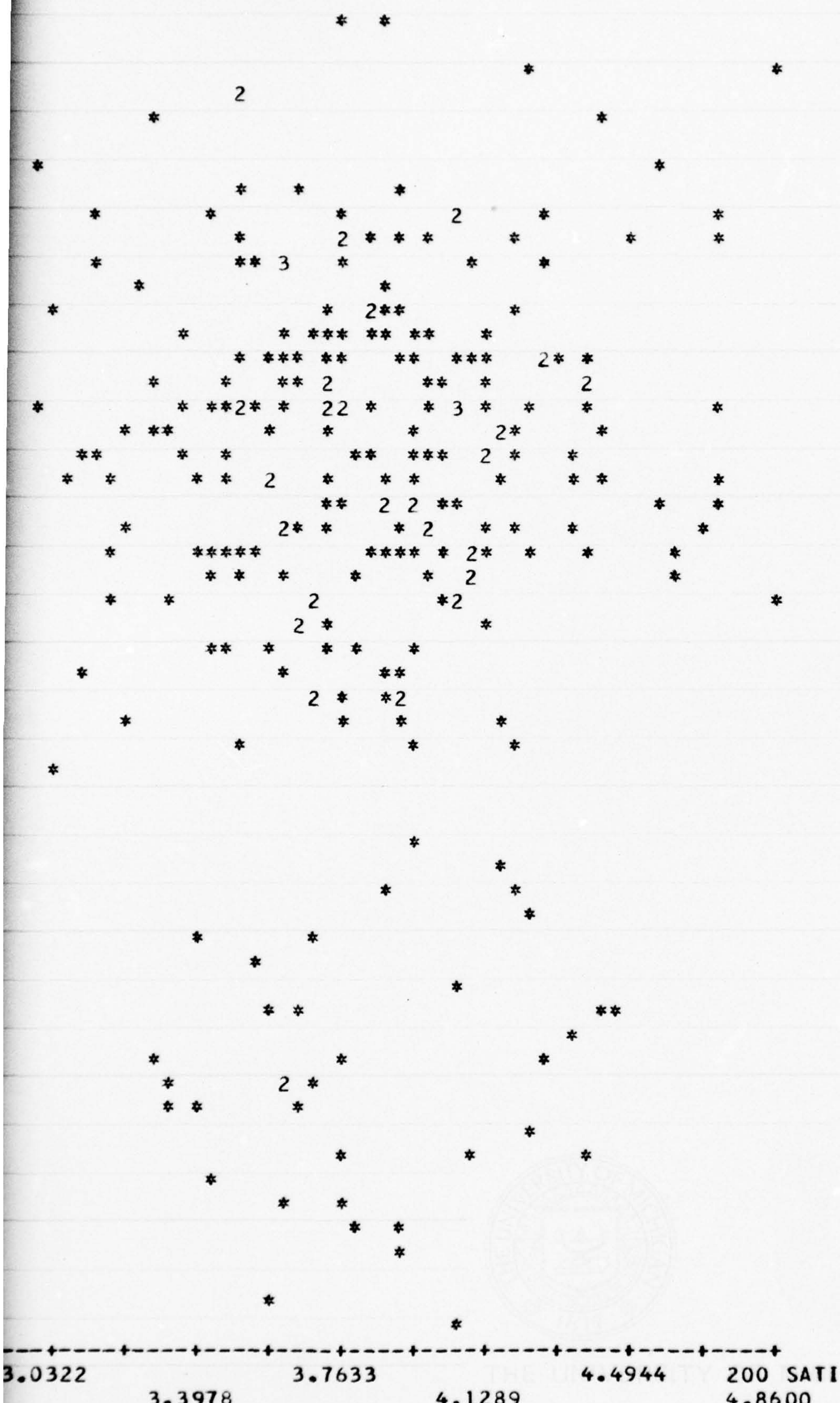
2



SCATTER PLOT



B-249



*5*********6*********7*********8*********9*********0*********1*********2*********3*

APPENDIX C

HISTOGRAM OF RESIDUAL VALUES FOR TVE PERIODS A-I AND ABS PERIODS A-J.

HISTOGRAM TVE PERIOD A


```
MIDPOINT    HIST%  COUNT FOR 941.V941  (EACH X= 1)

-1.2412       .5     1 +X
-.99121      1.6     3 +XXX
-.74121      6.4    12 +XXXXXXXXXXXX
-.49121     13.3    25 +XXXXXXXXXXXXXXXXXXXXXXXXX
-.24121     23.4    44 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .87933 -2  25.5    48 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .25879     12.2    23 +XXXXXXXXXXXXXXXXXXXXXXX
 .50879      9.6    18 +XXXXXXXXXXXXXXXXXX
 .75879      2.1     4 +XXXX
 1.0088      1.6     3 +XXX
 1.2588      1.1     2 +XX
 1.5088       .5     1 +X
 1.7588      0.      0 +
 2.0088      0.      0 +
 2.2588       .5     1 +X
 2.5088      1.1     2 +XX
 2.7588       .5     1 +X

 MISSING          2131
 TOTAL            2319  (INTERVAL WIDTH= .25000)
```

```
HISTOGRAM

MIDPOINT    HIST%  COUNT FOR 942.V942  (EACH X= 1)

-1.0830        .8     1 +X
-.83301       1.6     2 +XX
-.58301       3.9     5 +XXXXX
-.33301      22.0    28 +XXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.83015 -1   44.1    56 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .16699      17.3    22 +XXXXXXXXXXXXXXXXXXXXXX
 .41699       5.5     7 +XXXXXXX
 .66699       0.      0 +
 .91699       1.6     2 +XX
 1.1670       0.      0 +
 1.4170       0.      0 +
 1.6670       0.      0 +
 1.9170       0.      0 +
 2.1670       0.      0 +
 2.4170        .8     1 +X
 2.6670       0.      0 +
 2.9170       1.6     2 +XX
 3.1670        .8     1 +X

 MISSING           2192
 TOTAL             2319  (INTERVAL WIDTH= .25000)
```

TVE PERIOD C


```
HISTOGRAM

MIDPOINT    HIST%  COUNT FOR 943.V943  (EACH X= 1)

-1.7102         .2      1 +X
-1.4602        0.       0 +
-1.2102         .7      3 +XXX
-.96021        3.2     14 +XXXXXXXXXXXXXX
-.71021       13.1     58 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.46021       16.7     74 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.21021       18.1     80 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .39789 -1    13.3     59 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .28979       10.9     48 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .53979        9.3     41 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .78979        5.0     22 +XXXXXXXXXXXXXXXXXXXXXX
 1.0398        3.2     14 +XXXXXXXXXXXXXX
 1.2898        2.9     13 +XXXXXXXXXXXXX
 1.5398        2.5     11 +XXXXXXXXXXX
 1.7898         .7      3 +XXX
 2.0398         .2      1 +X

 MISSING            1877
 TOTAL              2319  (INTERVAL WIDTH= .25000)
```

C-4

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HISTOGRAM   TVE PERIOD D

```
MIDPOINT    HIST%  COUNT FOR 944.V944  (EACH X= 1)

-2.2612        .2     1 +X
-2.0112        .4     2 +XX
-1.7612       1.2     6 +XXXXXX
-1.5112       2.6    13 +XXXXXXXXXXXXX
-1.2612       2.0    10 +XXXXXXXXXX
-1.0112       8.1    41 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.76123      12.1    61 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.51123      10.9    55 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.26123      15.2    77 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.11226 -1   13.5    68 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .23877       8.3    42 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .48877       4.2    21 +XXXXXXXXXXXXXXXXXXXXX
 .73877       3.2    16 +XXXXXXXXXXXXXXXX
 .98877       2.4    12 +XXXXXXXXXXXX
 1.2388       4.2    21 +XXXXXXXXXXXXXXXXXXXXX
 1.4888       2.8    14 +XXXXXXXXXXXXXX
 1.7388       2.6    13 +XXXXXXXXXXXXX
 1.9888       1.4     7 +XXXXXXX
 2.2388       2.4    12 +XXXXXXXXXXXX
 2.4888       2.0    10 +XXXXXXXXXX
 2.7388        .4     2 +XX
 2.9888        .2     1 +X

 MISSING             1814
 TOTAL               2319   (INTERVAL WIDTH= .25000)
```

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```
HISTOGRAM          TVE PERIOD E

MIDPOINT    HIST%  COUNT FOR 945.V945  (EACH X= 1)

-2.0255       .7      3 +XXX
-1.7755       .5      2 +XX
-1.5255       .2      1 +X
-1.2755      1.6      7 +XXXXXXX
-1.0255      7.0     31 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.77547     12.4     55 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.52547     17.6     78 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.27547     15.8     70 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXYXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.25467 -1  13.6     60 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .22453      7.0     31 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .47453      2.5     11 +XXXXXXXXXXX
 .72453      2.7     12 +XXXXXXXXXXXX
 .97453      1.8      8 +XXXXXXXX
 1.2245      3.6     16 +XXXXXXXXXXXXXXXX
 1.4745      4.5     20 +XXXXXXXXXXXXXXXXXXXX
 1.7245      2.7     12 +XXXXXXXXXXXX
 1.9745       .9      4 +XXXX
 2.2245      1.8      8 +XXXXXXXX
 2.4745      1.8      8 +XXXXXXXX
 2.7245       .9      4 +XXXX
 2.9745       .2      1 +X

 MISSING           1877
 TOTAL             2319  (INTERVAL WIDTH= .25000)
```

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HISTOGRAM TVE PERIOD F

MIDPOINT	HIST%	COUNT FOR 946.V946 (EACH X= 1)	
-1.7586	.5	1	+X
-1.5086	1.0	2	+XX
-1.2586	4.0	8	+XXXXXXXX
-1.0086	5.6	11	+XXXXXXXXXXX
-.75856	10.1	20	+XXXXXXXXXXXXXXXXXXXX
-.50856	9.6	19	+XXXXXXXXXXXXXXXXXXX
-.25856	12.1	24	+XXXXXXXXXXXXXXXXXXXXXXXX
-.85557 -2	16.7	33	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.24144	14.6	29	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.49144	11.6	23	+XXXXXXXXXXXXXXXXXXXXXXX
.74144	6.1	12	+XXXXXXXXXXXX
.99144	1.5	3	+XXX
1.2414	1.5	3	+XXX
1.4914	.5	1	+X
1.7414	1.0	2	+XX
1.9914	1.0	2	+XX
2.2414	.5	1	+X
2.4914	.5	1	+X
2.7414	0.	0	+
2.9914	0.	0	+
3.2414	1.0	2	+XX
3.4914	.5	1	+X

MISSING 2121
TOTAL 2319 (INTERVAL WIDTH= .25000)

HISTOGRAM

MIDPOINT	HIST%	COUNT FOR 947.V947	(EACH X= 1)
-.61570	2.0	1	+X
-.36570	13.7	7	+XXXXXXX
-.11570	41.2	21	+XXXXXXXXXXXXXXXXXXXXX
.13430	29.4	15	+XXXXXXXXXXXXXXX
.38430	7.8	4	+XXXX
.63430	3.9	2	+XX
.88430	2.0	1	+X

MISSING 2268
TOTAL 2319 (INTERVAL WIDTH= .25000)

HISTOGRAM

MIDPOINT	HIST%	COUNT	FOR 948.V948 (EACH X= 1)
-1.0402	4.4	2	+XX
-.79020	0.	0	+
-.54020	8.9	4	+XXXX
-.29020	15.6	7	+XXXXXXX
-.40200 -1	28.9	13	+XXXXXXXXXXXXX
.20980	31.1	14	+XXXXXXXXXXXXXX
.45980	4.4	2	+XX
.70980	2.2	1	+X
.95980	2.2	1	+X
1.2098	2.2	1	+X

MISSING 2274
TOTAL 2319 (INTERVAL WIDTH= .25000)

HISTOGRAM — TVE PERIOD I —

```
MIDPOINT     HIST%  COUNT FOR 949.V949  (EACH X= 1)

-1.5805         .2      1 +X
-1.3305         .7      3 +XXX
-1.0805        5.9     24 +XXXXXXXXXXXXXXXXXXXXXXXX
-.83051       10.3     42 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.58051        8.3     34 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.33051       13.0     53 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.80511  -1   21.5     88 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .16949       16.9     69 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .41949        5.9     24 +XXXXXXXXXXXXXXXXXXXXXXXX
 .66949        3.2     13 +XXXXXXXXXXXXX
 .91949        1.0      4 +XXXX
 1.1695        3.9     16 +XXXXXXXXXXXXXXXX
 1.4195        6.6     27 +XXXXXXXXXXXXXXXXXXXXXXXXXXX
 1.6695        2.7     11 +XXXXXXXXXXX

 MISSING             1910
 TOTAL               2319  (INTERVAL WIDTH= .25000)
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C-10

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HISTOGRAM — ABS PERIOD A

```
MIDPOINT    HIST%   COUNT FOR 980.V980  (EACH X= 1)

-2.1432       1.2       3 +XXX
-1.8932        .8       2 +XX
-1.6432       4.3      11 +XXXXXXXXXXX
-1.3932       2.4       6 +XXXXXX
-1.1432       5.9      15 +XXXXXXXXXXXXXXX
-.89323       5.9      15 +XXXXXXXXXXXXXXX
-.64323       8.3      21 +XXXXXXXXXXXXXXXXXXXXX
-.39323       8.7      22 +XXXXXXXXXXXXXXXXXXXXXX
-.14323      13.0      33 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .10677      13.8      35 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .35677       9.1      23 +XXXXXXXXXXXXXXXXXXXXXXX
 .60677       8.3      21 +XXXXXXXXXXXXXXXXXXXXX
 .85677       5.9      15 +XXXXXXXXXXXXXXX
1.1068         .4       1 +X
1.3568        3.1       8 +XXXXXXXX
1.6068        3.1       8 +XXXXXXXX
1.8568        2.0       5 +XXXXX
2.1068        2.4       6 +XXXXXX
2.3568         .8       2 +XX
2.6068         .8       2 +XX

 MISSING              2065
 TOTAL                2319   (INTERVAL WIDTH= .25000)
```

```
HISTOGRAM                 ABS PERIOD B

MIDPOINT    HIST%  COUNT FOR 981.V981  (EACH X= 1)

-1.7184        .5      2 +XX
-1.4684        .3      1 +X
-1.2184        .3      1 +X
-.96843       4.4     17 +XXXXXXXXXXXXXXXXX
-.71843       6.2     24 +XXXXXXXXXXXXXXXXXXXXXXXX
-.46843      13.9     54 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.21843      23.9     93 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .31570 -1   19.8     77 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .28157      14.1     55 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .53157       6.7     26 +XXXXXXXXXXXXXXXXXXXXXXXXXX
 .78157       3.6     14 +XXXXXXXXXXXXXX
 1.0316       1.5      6 +XXXXXX
 1.2816       2.3      9 +XXXXXXXXX
 1.5316        .3      1 +X
 1.7816        .8      3 +XXX
 2.0316        .5      2 +XX
 2.2816      0.        0 +
 2.5316      0.        0 +
 2.7816        .3      1 +X
 3.0316        .5      2 +XX
 3.2816        .3      1 +X

 MISSING            1930
 TOTAL              2319  (INTERVAL WIDTH= .25000)
```

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```

HISTOGRAM ABS PERIOD C

```
MIDPOINT    HIST%  COUNT FOR 982.V982  (EACH X= 1)

-1.9098        .7      3 +XXX
-1.6598       2.5     11 +XXXXXXXXXXX
-1.4098       3.7     16 +XXXXXXXXXXXXXXXX
-1.1598       1.2      5 +XXXXX
-.90983       1.6      7 +XXXXXXX
-.65983       7.4     32 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.40983      17.3     75 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.15983      18.4     80 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .90166 -1   13.6     59 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .34017      11.5     50 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .59017       6.0     26 +XXXXXXXXXXXXXXXXXXXXXXXXXX
 .84017       6.2     27 +XXXXXXXXXXXXXXXXXXXXXXXXXXX
 1.0902       3.9     17 +XXXXXXXXXXXXXXXXX
 1.3402       3.0     13 +XXXXXXXXXXXXX
 1.5902       1.2      5 +XXXXX
 1.8402        .5      2 +XX
 2.0902        .5      2 +XX
 2.3402       0.       0 +
 2.5902       0.       0 +
 2.8402        .9      4 +XXXX

MISSING             1885
 TOTAL              2319  (INTERVAL WIDTH= .25000)
```

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HISTOGRAM ABS PERIOD D

MIDPOINT	HIST%	COUNT FOR 983.V983 (EACH X= 1)
-.97916	2.5	3 +XXX
-.72916	5.0	6 +XXXXXX
-.47916	19.0	23 +XXXXXXXXXXXXXXXXXXXXXXX
-.22916	29.8	36 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.20843 -1	8.3	10 +XXXXXXXXXX
.27084	9.9	12 +XXXXXXXXXXXX
.52084	9.1	11 +XXXXXXXXXXX
.77084	9.1	11 +XXXXXXXXXXX
1.0208	6.6	8 +XXXXXXXX
1.2708	.8	1 +X

MISSING 2198
TOTAL 2319 (INTERVAL WIDTH= .25000)

HISTOGRAM ABS PERIOD E

MIDPOINT HIST% COUNT FOR 984.V984 (EACH X= 1)

MIDPOINT	HIST%	COUNT	
-2.0384	1.2	5	+XXXXX
-1.7884	1.6	7	+XXXXXXX
-1.5384	7.6	33	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-1.2884	5.1	22	+XXXXXXXXXXXXXXXXXXXXXX
-1.0384	7.6	33	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.78839	7.6	33	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.53839	5.8	25	+XXXXXXXXXXXXXXXXXXXXXXXXX
-.28839	4.4	19	+XXXXXXXXXXXXXXXXXXX
-.38389 -1	6.7	29	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.21161	10.1	44	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.46161	11.3	49	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.71161	11.5	50	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.96161	8.8	38	+XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.2116	3.7	16	+XXXXXXXXXXXXXXXX
1.4616	3.5	15	+XXXXXXXXXXXXXXX
1.7116	1.2	5	+XXXXX
1.9616	.7	3	+XXX
2.2116	.5	2	+XX
2.4616	.2	1	+X
2.7116	.9	4	+XXXX
2.9616	.2	1	+X

MISSING 1885
TOTAL 2319 (INTERVAL WIDTH= .25000)

```
HISTOGRAM          ABS PERIOD F

MIDPOINT    HIST%   COUNT FOR 985.V985  (EACH X= 1)

-1.6329       .6      2 +XX
-1.3829       .6      2 +XX
-1.1329      5.1     18 +XXXXXXXXXXXXXXXXXX
-.88288      8.3     29 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.63288     10.3     36 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.38288     10.5     37 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.13288     15.4     54 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .11712     13.4     47 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .36712     12.0     42 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .61712     15.4     54 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .86712      4.6     16 +XXXXXXXXXXXXXXXX
 1.1171       .9      3 +XXX
 1.3671       .3      1 +X
 1.6171       .3      1 +X
 1.8671      0.       0 +
 2.1171       .9      3 +XXX
 2.3671       .9      3 +XXX
 2.6171       .9      3 +XXX

 MISSING           1968
 TOTAL             2319  (INTERVAL WIDTH= .25000)
```

ABS PERIOD G

```
HISTOGRAM

MIDPOINT     HIST%   COUNT FOR 986.V986   (EACH X= 1)

-1.7387         .6       2 +XX
-1.4887        3.0      10 +XXXXXXXXXX
-1.2387        4.5      15 +XXXXXXXXXXXXXXX
-.98869        6.3      21 +XXXXXXXXXXXXXXXXXXXXX
-.73869       11.9      40 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.48869       12.2      41 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.23869       11.6      39 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .11305 -1     7.7      26 +XXXXXXXXXXXXXXXXXXXXXXXXXX
 .26131        7.1      24 +XXXXXXXXXXXXXXXXXXXXXXXX
 .51131        7.1      24 +XXXXXXXXXXXXXXXXXXXXXXXX
 .76131       11.6      39 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 1.0113        8.3      28 +XXXXXXXXXXXXXXXXXXXXXXXXXXXX
 1.2613        4.8      16 +XXXXXXXXXXXXXXXX
 1.5113        1.5       5 +XXXXX
 1.7613        1.8       6 +XXXXXX

 MISSING              1983
 TOTAL                2319   (INTERVAL WIDTH= .25000)
```

HISTOGRAM — ABS PERIOD H —

```
MIDPOINT    HIST%  COUNT FOR 987.V987  (EACH X= 1)

-1.5548      1.4     4 +XXXX
-1.3048      2.1     6 +XXXXXX
-1.0548      3.5    10 +XXXXXXXXXX
-.80482      2.1     6 +XXXXXX
-.55482      7.6    22 +XXXXXXXXXXXXXXXXXXXXXX
-.30482     17.6    51 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.54823 -1  19.4    56 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .19518     18.0    52 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .44518     18.0    52 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .69518      6.9    20 +XXXXXXXXXXXXXXXXXXXX
 .94518      1.0     3 +XXX
 1.1952      1.7     5 +XXXXX
 1.4452       .3     1 +X
 1.6952      0.      0 +
 1.9452      0.      0 +
 2.1952      0.      0 +
 2.4452       .3     1 +X

  MISSING           2030
  TOTAL             2319   (INTERVAL WIDTH= .25000)
```

HISTOGRAM — ABS PERIOD H —

```
MIDPOINT      HIST%   COUNT FOR 987.V987  (EACH X= 1)

-1.5548         1.4      4 +XXXX
-1.3048         2.1      6 +XXXXXX
-1.0548         3.5     10 +XXXXXXXXXX
-.80482         2.1      6 +XXXXXX
-.55482         7.6     22 +XXXXXXXXXXXXXXXXXXXXXX
-.30482        17.6     51 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.54823 -1     19.4     56 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .19518        18.0     52 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .44518        18.0     52 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .69518         6.9     20 +XXXXXXXXXXXXXXXXXXXX
 .94518         1.0      3 +XXX
 1.1952         1.7      5 +XXXXX
 1.4452          .3      1 +X
 1.6952         0.       0 +
 1.9452         0.       0 +
 2.1952         0.       0 +
 2.4452          .3      1 +X

 MISSING              2030
 TOTAL                2319   (INTERVAL WIDTH= .25000)
```

```
HISTOGRAM

MIDPOINT    HIST%  COUNT FOR 988.V988  (EACH X= 1)

-1.6259       .8     2 +XX
-1.3759       .4     1 +X
-1.1259      3.0     8 +XXXXXXXX
-.87593      6.0    16 +XXXXXXXXXXXXXXXX
-.62593     13.9    37 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.37593     15.4    41 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-.12593     15.4    41 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .12407     13.5    36 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .37407      8.3    22 +XXXXXXXXXXXXXXXXXXXXXX
 .62407      7.1    19 +XXXXXXXXXXXXXXXXXXX
 .87407      6.4    17 +XXXXXXXXXXXXXXXXX
 1.1241      4.9    13 +XXXXXXXXXXXXX
 1.3741      3.8    10 +XXXXXXXXXX
 1.6241      1.1     3 +XXX

 MISSING           2053
 TOTAL             2319  (INTERVAL WIDTH= .25000)
```

HISTOGRAM ABS PERIOD J

```
MIDPOINT    HIST%   COUNT FOR 989.V989  (EACH X= 1)

-1.3498       1.1      3 +XXX
-1.0998       4.1     11 +XXXXXXXXXXX
-.84981       5.6     15 +XXXXXXXXXXXXXXX
-.59981       2.6      7 +XXXXXXX
-.34981       7.1     19 +XXXXXXXXXXXXXXXXXXX
-.99810 -1   21.8     58 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .15019      33.1     88 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .40019      18.4     49 +XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 .65019       5.3     14 +XXXXXXXXXXXXXX
 .90019        .8      2 +XX

 MISSING            2053
 TOTAL              2319  (INTERVAL WIDTH= .25000)
```

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